MANUAL AND PART LISTS

BEHLMAN MODEL KBT-50-C-SZ76

PROGRAMMABLE A.C. POWER SUPPLY

SERIAL #2265,2266

MP MASTER

MA29409

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Behlman
Engineering Corporation

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If equipment is returned to the factory without prior authorization the customer is liable for all shipping, handling and repair costs.

When packaging for re-shippment, use adequate shock-absorbent material within shipping container to preclude damage to the equipment.

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SECTION 1 INTRODUCTION AND SPECIFICATIONS

1.1 GENERAL DESCRIPTION

The Behlman model KBT-50-C-SZ76 is a highly sophisticated Programmable AC Power Supply with intergrated measurement capabilities that provide independent verification of operating values, thus reducing the need for external measurement instrumentation. Control of the power supply output voltage and frequency is with a front panel keyboard entry system or via the General Purpose Interface Bus (GPIB). Reporting of the output voltage, frequency and load current measurements is by a front panel alpha-numeric display.

A unique feature of the power supply is the microprocessor controlled synthesized sinewave oscillator. This oscillator generates very accurate and stable output voltages and frequencies and, through the use of the keyboard or GPIB, provides the user with excellent control resolution.

The conservative design approach of the power amplifier section allows for full volt-ampere and current ratings into loads having power factors down to zero, either leading or lagging. In addition, an extremely high degree of feedback is used to help achieve low output distortion and tight line and load regulation. The output power is transformer coupled to provide excellent load isolation.

The model KBT-50-C-SZ76 is capable of providing up to 500 volt-amperes of single phase power over a frequency range of 45-2000 Hz. A front panel output voltage switch provides two fixed output ranges, 0-135 and 0-270 Vac, and a 0-270 Vac autorange with automatic change at 135 Vac.

The fixed output ranges of 0-135 and 0-270 volts produce full power between 100-135 and 200-270 volts with proportional output power between 0-100 and 0-200 volts, respectively. The autorange provides full power over the 100-135 and 200-270 voltage ranges, and produces proportional output power when used between 0-100 and 135-200 volts.

A front panel keyswitch provides locking REMOTE and LOCAL operating modes, as well as the LOCK position which inhibits new operating values from being entered.

Under conditions of nominal input line voltage, unity power factor load, 130 or 260 volts output and output frequency between 55 and 1600 Hz, this power supply will provide up to 750 volt-amperes output continuously.

The input power requirement is 115 Vac, 10 amperes or 230 Vac, 5 amperes, 48-72 Hz, single phase.

1.2 SPECIFICATIONS

MODEL KBT-50-C-SZ76

INPUT POWER:	115 Vac, 10 amperes or 230 Vac, 5 amperes, 48-72 Hz, single phase.
RATED OUTPUT POWER:	500 volt-amperes, single phase.
MAXIMUM OUTPUT POWER:	750 volt-amperes, single phase. (Unity P.F. load, 130 or 260 Vac output, 55-1600 Hz, nominal input line.)
OUTPUT VOLTAGE RANGES:	Fixed ranges of 0-135 and 0-270 Vac, and 0-270 autorange with automatic change at 135 Vac.
FULL POWER RANGES:	100-135 Vac and 200-270 Vac.
RATED CURRENT:	5 amperes in 0-135 Vac range. 2.5 amperes in 0-270 and 135-270 Vac ranges.
MAXIMUM CURRENT:	6 amperes in 0-135 Vac range. 3 amperes in 0-270 and 135-270 Vac ranges. (Unity power factor load.)
FREQUENCY RANGE:	45-2000 Hz
FREQUENCY RESOLUTION	0.1 Hz. steps.
FREQUENCY ACCURACY:	$^{+}$-0.05%
VOLTAGE RESOLUTION	0.1 volt steps, 0-270.0 volts.
VOLTAGE ACCURACY:	$^{+}$-0.2% of full scale
AMMETER ACCURACY:	$^{+}$-0.5% of full scale
DISTORTION:	1% maximum THD.
LOAD POWER FACTOR:	Down to zero leading or lagging, at 25^{o}C ambient.
LOAD REGULATION:	$^{+}$-0.5% no load to full load.
OVERLOAD AND SHORT CIRCUIT PROTECTION:	Instantaneous electronic protector plus line circuit breaker. Electronic protector returns output to normal as soon as overload or short circuit is removed.
SIZE:	7"Hx19"Wx19"D
WEIGHT:	70 lbs.

1.2.1 SOFTWARE LOG

PROM #1 LT11/1.6

PROM #2 LT12/1.2

1.2.2 OPTIONS:

EXTERNAL INPUT:	0-9.2 Vac, single-phase, 150-2000 Hz. (Drives amplifier from zero to maximum output voltage.)
INPUT IMPEDANCE:	15,000 ohms.
SYNC INPUT	2-10 Vac sinewave.

SECTION 2 UNPACKING AND INSTALLATION

2.1 UNPACKING

After unpacking the power supply, conduct a thorough inspection of controls, indicators and chassis. If the power supply shows signs of damage do not attempt to operate. File a damage claim with the carrier responsible. Notify Behlman Engineering immediately.

2.2 INSTALLATION

1) This equipment is intended as a rack mounting unit. When installing in a rack or cabinet support under the chassis must be provided. Do not attempt to mount by front panel only. For proper cooling air circulation the following clearances must be provided:

3/4 inches above chassis (or cabinet)
8 inches at the rear of chassis (or cabinet)

2) Be sure LINE circuit breaker and all other controls are in OFF position before connecting input power.

3) Place INPUT SELECT switch, located at the rear of the instrument, in 115 or 230 VAC position as required. Connect line cord to power connector on the rear of the instrument and then to power-line receptacle. (Input line fuse is same for either input voltage).

4) On models with optional GPIB programming, connect GPIB cable to GPIB connector located at the rear of the instrument.

SECTION 3 OPERATION

3.1 OPERATION-LOCAL

3.1.1 INTRODUCTION

A keyboard entry system is used for manual control of output frequency and output voltage. Frequency and voltage selections are entered into 0-9 and decimal point keys, after entering a change command into either the "F" (frequency) or "V" (voltage) key. The "F" or "V" key clears the readout for the presentation of the new value, but does not change the previous operating value until the "E" (enter) key is pushed.

"∧" and "∨" keys are used to increment or decrement the output frequency or voltage in steps of 0.1 or larger. (Note: Above 1000.0 Hz the minimum frequency change is 1.0 Hz, even though the keyboard allows entry in tenths.)

A front panel keyswitch provides locking REMOTE and LOCAL operating modes, as well as the LOCK position which inhibits new operating values from being entered.

A front panel OUTPUT RANGE switch provides two fixed output voltage ranges 0-135 and 0-270 Vac, and a 0-270 AUTORANGE with an automatic range change at 135 volts.

The error messages for incorrect data entry are "NO PREVIOUS INCREMENT INPUT", "INPUT FORMAT ERROR" or "INPUT TOO LONG, RE-ENTER PLEASE". The error message will be displayed for 5 seconds before reverting to the previous operating condition.

The alpha-numeric readout is used to display output frequency, voltage and load current. The values presented by the readout are the actual measured, not entered, values.

WARNING

This equipment involves the use of voltages and currents that can be hazardous. Only qualified personnel should be allowed to operate or service it. The top cover/s must always be in place during operation.

3.1.2 TURN ON PROCEDURE

1) Be sure LINE circuit breaker and OUTPUT switch are in OFF position.

2) Connect suitable load across output terminals. (Do not exceed rating of unit.) Load may be left floating or either side may be connected to ground.

3) Place keyswitch in the LOCAL position.

4) Place OUTPUT RANGE switch in desired output voltage range.
(Note: When the range switch is changed the output voltage goes to zero.)

5) Place LINE circuit breaker in ON position. (Red power indicator should light and cooling-fan noise should become evident.) The output will initialize at 0.0 volts, 400 Hz.

6) Set OUTPUT FREQUENCY as follows:

1. Push "F" key to clear display for frequency change.
2. Enter desired frequency data. (Up to 1000.0 Hz with 0.1 Hz resolution, and above 1000.0 Hz with 1.0 Hz resolution.)
3. Push "E" key to enter new frequency data.

7) Set OUTPUT VOLTAGE as follows:

1. Push "V" key to clear display for voltage change.
2. Enter desired voltage data. (0.1 volt resolution)
3. Push "E" key to enter new voltage data.

8) Place OUTPUT switch in ON position to energize load. (Note load current on readout.)

3.1.3 INCREMENTAL STEPPING

Incremental stepping of the output frequency or voltage is accomplished as follows:

1. Push "F" key to change frequency or "V" key to change voltage.
2. Enter desired step change of 0.1 or larger.
3. Push "∧" (increment) or "∨" (decrement) key as desired.
4. Push "∧" or "∨" again to repeat step change.
5. Enter new step value then push "∧" or "∨" to change step size.

Note: The power supply will step only to the limits of its frequency and voltage specifications.

3.1.4 LOCAL/LOCK/REMOTE KEYSWITCH

1) The LOCAL position enables the entry of data from the front panel keyboard while disabling any programming from the remote interface. This mode cannot be entered from REMOTE if a programming change is being made or if the unit has been placed in Local Lockout by the remote interface.

2) The REMOTE position enables the remote interface to send commands to the unit. When in this mode, local programming, via keyboard and other controls, is possible until the remote interface disables it by programming the Remote Enable (REN) command. After the REN has been sent, programming is accomplished via the remote interface until the Go to Local command is sent over the remote interface. This command again enables the unit to be programmed via the front panel.

3) The LOCK position inhibits programming of the unit from keyboard or remote interface without affecting current programmed values. This mode cannot be entered if a programming change is being input. Although the switch can be actuated the change will be ignored until the programming change is completed.

3.1.5 OUTPUT RANGE CONTROL

The OUTPUT RANGE control allows user selection of one of three output voltage ranges, 0-135 and 0-270 volts, and AUTORANGE. The 0-135 volt, low, range restricts the output voltage to 135 volts and allows full power between 100 and 135 volts. In the 0-270 volt, high, range the unit can be programmed to 270 volts and allows full power between 200 and 270 volts. The AUTORANGE allows voltage programming from 0-270 volts with automatic range change from low to high at 135 volts. In AUTORANGE, full power is drawn in two voltage bands, 100-135 volts and 200-270 volts.

3.1.6 EXTERNAL INPUT (OPTIONAL)

The INT/EXT switch, located on the rear of the instrument, disconnects the signal generating circuitry of the power supply while providing access to the input of the power amplifier. A BNC connector is provided on the rear of the instrument for application of an external amplifier driver signal. The internal measurement system will measure the output voltage of the amplifier and the load current, however, it will not measure the frequency of the external input signal. (The frequency of the internal oscillator will continue to be displayed.)

1) Place INT/EXT switch in the EXT position.

2) Use keyboard to enter the highest output voltage desired. (The auto-ranging feature is disabled when using an external signal.)

3) Apply 0-9.2 Vac drive to signal AMPLIFIER DRIVE connector until desired output voltage level is obtained. (Be sure signal is within frequency specification of amplifier.)

3.1.7 EXTERNAL SYNC INPUT (OPTIONAL)

This option allows syncronization of the power supply output to an external signal source. The input signal required is 2.5 to 10 Vac and must be within the frequency bandwidth of the power supply. (The operating frequency of the power supply should be the same as the sync signal, however, this is not mandatory.) Apply the sync signal to the EXT SYNC connector located on the instrument.

3.1.8 SHUTDOWN PROCEDURE

1) Place OUTPUT switch in OFF position.

2) Place LINE circuit breaker in OFF position.

3.2 OPERATION - REMOTE

3.2.1 INTRODUCTION

Remote programming of the power supply is via the General Purpose Interface Bus (GPIB), which was adopted as the IEEE-488 standard in 1975. Minor revisions and improvements regarding technical interpretation were made in 1978 and 1980. The American National Standards Institute publishes the GPIB as ANSI Standard MC1.1 and the International Electrotechnical Commission as IEC 625.1. Except for minor differences the IEC 625.1 may be considered identical to the IEEE-488 standard.

This model has been configured with the "Listener" GPIB programming option.

The following features are implemented:

1. Control of all front panel functions can be overridden by the IEEE-488 interface.
2. Remote/Local Changeover, with Local Lockout. A standard. LOCAL/LOCK/REMOTE keyswitch is also provided.
3. Listener Extended Addressing.
4. Selected Device Clear, Device Clear and Interface Clear.

3.2.2 ADDRESS SWITCH

The address switch is located on the instrument rear panel. Any address from 0 through 30 (decimal) may be selected using the five switch segments. A switch in the ON (up) position is logic 0. Address 6 would be:

	1	2	3	4	5	Switch segment
	0	1	1	0	0	Switch logic
	2^0	2^1	2^2	2^3	2^4	Binary value
ON OFF						Switch setting

3.2.3 LISTENER EXTENDED (LE) ADDRESSING

The Extended Addressing feature of the GPIB is used to select certain operating modes of the instrument. The valid Secondary Listen Addresses are:

1.	112 (ASCII 'p')	Listener, with output load ON.
2.	113 (ASCII 'q')	Listener, with output load OFF.
3.	115 (ASCII 's')	Listener, set range 2, high range.
4.	116 (ASCII 't')	Listener, set range 1, low range.
5.	117 (ASCII 'u')	Listener, set range 0, auto range.

To change the state of the output load relay the controller must send the correct secondary address: 112 (ASCII 'p') to energize the load relay and 113 (ASCII 'q') to de-energize the load relay. (When programming the output ON, the output switch must also be ON. In addition, the output switch will turn the output relay OFF regardless of the programming commands. This provides positive manual-shutdown of the output of the power supply if necessary.)

To change the output range of the unit the controller sends the desired secondary address. These can be sent at anytime the Listener is in the listen state. Anytime a range change command is sent the Listener will drop the output voltage to zero automatically.

(Note: If, upon returning to local operation, the range programmed via IEEE and the range set on the front panel differ, the range will revert to front panel setting and the voltage will go to zero.)

3.2.4 REMOTE/LOCAL CHANGEOVER (RLC)

Upon "power-up" the power supply (P/S) initializes in the Local operation mode. In order to remotely program, the user must first set the Remote Enable (REN) uni-line message true, then send the Listen Address (as selected by the address switch), and finally, send any of the valid Secondary Listen Addresses. This puts the Listener in the remote mode and completes the addressing of the P/S to listen.

The P/S will ignore any Secondary Listen Address unless the Remote Enable (REN) uni-line message is true. This keeps the P/S from responding to any listener address commands unless in the Remote mode. In the Remote mode the front panel keyboard is disabled. To return to the Local mode the Go to Local (GTL) command must be sent.

After being addressed to listen, the P/S will respond to any of the listen commands: data, Selected Device Clear, Go to Local, etc.

3.2.5 LOCAL/LOCK/REMOTE KEYSWITCH

The following aspects should be considered when programming those models with a front panel LOCAL/LOCK/REMOTE keyswitch:

1. LOCAL Mode (Remote Lockout)
When the keyswitch is in the LOCAL position the P/S will not respond to any bus commands. It will, however, continuously monitor the bus, and will complete required handshaking. In addition, even after the mode switch is placed in the REMOTE position the P/S will remain in Local operation until the Remote Enable (REN) command is sent.

2. REMOTE Mode
The RLC must only be done with the keyswitch in the REMOTE position and when the P/S is not busy. (See Status Byte Section for ways of determining state.) Trying to program into the Remote mode when these conditions are not met will cause the P/S to ignore the REN. The P/S must be cleared by a GTL command, and then meet the above conditions, before another REN may be sent.

3. Local Lockout (LLO) Command
The LLO command allows the user to disable the keyswitch when the P/S is in the Remote mode. In addition, after placing the keyswitch in LOCAL, the P/S will not return to Local control until the GTL command is sent.

4. LOCK

With the keyswitch in the LOCK position the P/S will not respond to either front panel commands or GPIB commands. This mode cannot be entered from the Remote mode (by switching from REMOTE to LOCK) if the LLO command has been used.

3.2.6 PROGRAMMING FORMAT

Programming the output amplitude and frequency is accomplished by sending an ASCII data-string over the bus while the P/S is addressed to listen. (The output load relay may be either on or off.)

The data format is relatively simple. While the P/S is listening, and the Attention (ATN) line is false, data for operational changes are sent in the following format: (For the balance of this discussion ' ' denotes ASCII code.)

DATA	ASCII	DESCRIPTION
1. Function	'F' 'V'	Frequency Amplitude
2. Value	'0'-'9'	Operating value of frequency, voltage or phase angle.

Note: Value may be up to 6 characters, including '.' (decimal point).

3. Terminator	'E'	Programs operating value.
	'^' (cerat or up-arrow)	Value is added to present operating value.
	'v' (lower case "V")	Value is subtracted from present operating value.

Two exceptions to the above involve incremental programming, and must occur after (but not necessarily directly after) a P/S command-string terminated by '^' or 'v'.

1. '^' or 'v': Repeats the last '^' or 'v' command, in the direction (add or subtract) specified.

2. (Value) '^' or (Value) 'v': Changes the value of the last '^' or 'v' command and repeats it, with the new value, in the direction specified.

LISTENER PROGRAMMING EXAMPLE:

(* Indicates data is sent with ATN true.)

*	REN	Set Remote Enable uni-line message true.
*	UNL ('?')	Unaddress all listeners.
*	MTA	Controllers Talk Address.
*	'&'	P/S Listen address. (Address 6-per example.)
*	'q'	Secondary Address (Output load OFF).
	'F'	Frequency function.
	'1'	Set output frequency to 1000 Hz.
	'0'	
	'0'	
	'0'	
	'E'	Terminator.
	'V'	Amplitude function.
	'1'	Set output voltage to 115 volts.
	'1'	
	'5'	
	'E'	Terminator.
*	'p'	Secondary Address (Output load ON).
	'V'	Amplitude function.
	'1'	Decrement output voltage by 10 volts.
	'0'	
	'v'	
	'1'	Increment output voltage by 15 volts.
	'5'	
	'^'	
	'v'	Decrement output voltage by 15 volts.
*	's'	Secondary address (Set Range 2). (Note: Voltage returns to zero.)
	'V'	
	'1'	
	'3'	
	'0'	
	'E'	Set output voltage to 130 volts.
	'^'	Increments output voltage by 15 volts. (Note: Increment value previously set to 15 volts.)
*	'q'	Secondary Address (Output load OFF).
*	GTL (Decimal 01)	Go to Local (front panel) operation.

3.2.7 SELECTED DEVICE CLEAR (SDC), DEVICE CLEAR (DCL) AND INTERFACE CLEAR (IFC)

These commands allow the GPIB controller to put the P/S into a known state, in case of a bus "hang-up" or device failure.

The SDC and DCL commands may be used to return to the "power-up" state:

Frequency	400 Hz
Voltage	0.0 volts
GPIB interface	Cleared (Unaddressed)
Mode	Local

The IFC command allows the system controller to unconditionally assume control of the bus. This command clears the GPIB interface and reverts the P/S to the Local mode, without effecting the programmed operating values.

PROGAMMING EXAMPLE:

* Indicates data sent with ATN true.

* UNL ('?')	Unaddress all listeners.
* REN	Set REN uni-line message true.
* '&'	P/S Listen Address (Address 6-per example).
* 'q'	Secondary Address (Output load OFF).
* SDC (Decimal 04)	Send Selected Device Clear.
or	
* DCL (Decimal 20)	Send Device Clear.
or	
IFC	Set IFC uni-line message true. (Set by System Controller.)

SECTION 4 THEORY OF OPERATION

4.1 ELECTRICAL DESCRIPTION

An electrical signal, anywhere within the frequency range capability of the power amplifier, is generated by a microprocessor-controlled synthesized-sinewave oscillator. This signal is applied to the input of a driver amplifer. The output of the driver is applied to the input of a linear power amplifier. The power amplifier is transformer coupled to the output terminals located on the front and/or rear of the power supply. The output is isolated and can be left floating, or either side may be connected to ground.

A D.C. power supply section converts the A.C. input power to the various D.C. voltage and power levels required by the A.C. generating circuitry.

4.2 GPIB INTERFACE (OPTIONAL)

The GPIB interface acts as an extension of the front panel keyboard and output load switch. The same characters that appear on the keyboard may be sent over the bus, in ASCII, to set the output frequency and voltage. Seperate bus commands provide control of the other oscillator functions; ie, load ON/OFF, range change and REMOTE/LOCAL change over.

A Texas Instruments (TI) TMS9914 is used to provide the interface function between the GPIB and the A.C. Power Supply microprocessor. TI SN75160 and SN75161 bus transceivers are used to connect the TMS9914 to the GPIB data and management lines.

4.3 OSCILLATOR

The oscillator is a microprocessor controlled sine wave generator that provides independent control of the amplitude, phase angle of each phase and also control of the output frequency.

4.3.1 MICROPROCESSOR CARD

The internal microprocessor accepts commands from the keyboard or optional remote interface, decodes them and presents the programming to the oscillator control circuitry. Additionally, the microprocessor monitors the output waveform and reports measurements made on it to the display or optional remote interface.

The microprocessor is a 2MHz Z-80 based system with 12K of PROM and 1K of RAM. Data and commands are sent over a Motherboard arrangement via a full Z-80 I/O port.

Contained on the microprocessor card are the keyboard interface, display interface, 8 bit input port, and an 8 bit output port which are used to send and recieve data to and from the Amplifier and front panel.

4.3.2 FREQUENCY CARD

The frequency card generates a clock pulse at 360 times the output frequency by repeated dividing of a master clock. U22 and crystal X1 produce a master clock at 18MHz. This clock signal is sent to five cascaded digital rate multipliers. The multiplication value is derived from latched data, programmed by the microprocessor, at the two 8255 ICs', U8 and U10. The rated multipliers, U17, U20, U21, U23 and U24, effectively give the programmed number of output pulses for every 100,000 master clock pulses, giving a precise output frequency. This output frequency is then fed to a divide by five circuit, U13, to smooth out irregularities in the duty cycle. The resulting clock is buffered, U19, and is fed, via the Motherboard, to the Voltage card and its synthisization circuity.

Along with the master clock circuit, the Frequency card has provision for a IEEE-488 interface, a bidirectional parallel port interface, and the 0-10 volt frequency programming circuity.

4.3.3 VOLTAGE CARD

The voltage card contains the sine wave synthesization and amplitude control circuity. The clock signal produced on the Frequency card is fed in to a 360 step down counter. The 10 bit count is presented as addresses to a PROM which contains a lookup table for a 360 step, binary encoded, sine wave. The PROM outputs 360 bytes of data, at the output frequency rate, to a digital to analog converter (DAC). The DAC converts the binary encoded data that represents the sine wave into an analog sine wave. There is one synthesization circuit per phase. Phase separation is accomplished by loading offsets into the down counters of the B and C phases. The reset from the A phase down counter loads the offsets into the down counters for the B and C phases while loading zero into the A phase. This, then, starts the sine lookup address for the Band C phases at their offset values at the same time the A phase address is at zero, producing a phase shift between the phases.

Amplitude programming is accomplished by latching a binary number that represents a percent of full scale amplitude into a DAC. The DAC converts the binary value into an analog progamming voltage. The analog sine wave and the analog programming voltage are used by an analog multiplier IC to give an output sine wave that is amplitude controlled.

The voltage card also has provisions for the 0-10 Volt amplitude programming option.

4.3.4 MEASUREMENT CARD

The Measurement card collects amplitude, frequency, and current data from different sensors in the power supply and converts it to a form that is readable by the microprocessor. The frequency data is obtained by presenting the oscillator output to a binary counter that is enabled for precise, known intervals. The count, which is directly proportional to the output frequency, is read by the microprocessor and displayed as frequency.

The voltage across the output terminals is measured by applying it to a precision rectifier to produce a DC voltage that is directly proportional to the average output amplitude. This voltage is applied to an analog to digital converter (ADC) which produces a reading for the microprocessor circuitry.

Currents are measured by placing the primary of a toriodal transformer in the power output stage's final output current path. The secondary of the transformer is applied across a known resistance. The resulting voltage is presented to a precision rectifier and ADC as is the voltage measurement signal. The resulting digital output is read by the microprocessor as output current.

4.4 DRIVER

4.4.1 GENERAL DESCRIPTION

The driver provides push-pull signals, at appropriate voltage and current levels, to the input of the power output stage. The driver also provides output overload and short circuit sensing and protection functions.

4.4.2 ELECTRICAL DESCRIPTION

Variable voltage and frequency signals, from the oscillator, are applied to the input of the driver at R1. Negative feedback signals from the output of operational amplifier A3D are applied through R24. Summation of the oscillator and negative feedback signals is obtained at the junction of R1 and R24. Summation voltages are applied to the non-inverting input of op-amp A1, and to the inverting input of op-amp A2 through R3. This results in the generation of push-pull signals at the outputs of op-amps A1 and A2.

The voltage outputs of A1 and A2 are applied to the gates of the power FET's Q1 and Q2 through R22, D9 and R17, D10. Q1 and Q2 are used as source-followers and provide outputs at suitable voltage and current levels to drive the push-pull power-output stage.

Negative feedback voltages are generated by op-amp A3D. This amplifier is used in a differential mode, using signals derived from the primary of the power output transformer. Resistors R32 through R35 are used to reduce the D.C. and A.C. voltages, at the primary of the power output transformer, to levels for use by the op amp.

Positive feedback signals are used to provide additional reduction in the output impedance of the power output stage. Positive feedback voltage is derived at the output of op-amp A1 and applied to the summation junction of R1 and R24 through R37, R11, C6, R12 and R10. C4 is used to provide high frequency roll-off of the positive feedback signals. R11 is used to adjust the positive feedback to the desired level. This positive feedback arrangement provides very high gain in the operational band of frequencies. This high gain, combined with the very high degree of negative feedback, derived from the power output stage, provides a very low output impedance.

Driver output bias voltages are obtained by the use of R6 and R8.

POSITIVE FEEDBACK REDUCTION WITH LOW POWER FACTOR LOADS:

A method is utilized that increasingly reduces the positive feedback as the load power factor is decreased. This greatly improves the regulation from no-load to full-load when low power factor loads are used. It also greatly increases the margin of stability when using capacitive loads.

The arrangement monitors the difference in phase between the voltage across the load and the current through the load. It then reduces the positive feedback in proportion to the phase difference. The voltage signal is obtained from the output of negative feedback amplifier A3D. The current signal is derived from the output of driver amplifier A2. This voltage is in phase with the current through the load. These voltage and current signals are converted to square waves by overdriving op-amps A3A and A3B with them. These square waves are in phase with unity power factor loads, and increasingly out of phase as the load power factor is reduced.

When the square waves are in phase no current flows through the bridging resistor R21, nor through the light-emitting diodes in U1. U1 is a photoresistor/LED combination whose resistance varies inversely with current through the diodes. As the power factor of the load decreases the phase difference between the voltage and current derived square waves increases. This then allows A.C. current to flow through R21 and the diodes of U1. The photo-resistance is thereby lowered and shunts positive feedback, at the junction of R10 and R12, to ground.

OVERLOAD FUNCTIONS:

Excessive current through the load is reflected as high drive voltage at the outputs of source-followers Q1 and Q2. These high drive signals turn on Q3 which then loads the inputs to the gates of Q1 and Q2. This reduces the drive voltages, and thereby the output current, to pre-set and safe levels. Clipping of the output voltage results.

A foldback function is provided that reduces the maximum output current as output voltage is reduced or as the load on the output is increased. Op-amp A3C is used as a unity-gain amplifier which buffers the output of negative feedback amplifier A3D. The output of A3C is applied to D7 which results in a negative D.C. voltage appearing at the junction of D7, R13 and C5. This negative voltage is applied in such a way as to oppose and reduce the positive base signals appearing at Q3. As long as the output voltage is high enough to allow D8 to roughly regulate the negative voltage appearing across it, maximum current can be obtained through the load. If the negative voltage across D8 is reduced, either by very heavy loads across the power supply output or very low output voltage settings, there is less or no voltage to oppose the positive base signals. Therefore, Q3 will conduct at lower driver output voltages which results in conducting at lower output currents.

C5 and C7 provide time delays which allow 1) short-term, high-inrush currents and 2) high narrow-peak recurrent-currents through the load.

4.5 POWER-OUTPUT STAGE

4.5.1 GENERAL DESCRIPTION

The power-output stage takes low level signals from the driver and amplifies them to the power level required at the output of the A.C. Power Supply.

4.5.2 ELECTRICAL DESCRIPTION

The power-output stage is a push-pull stage employing transformer coupling between the collectors of NPN power transistors and the load terminals.

Two of the output stage transistors are connected in a darlington configuration. A push-pull signal from the driver is applied to the bases of the darlington transistors, which in turn drive the rest of the output transistors. Up to 30 output transistors may be driven by each darlington pair.

Resistors in the emmtter circuits of each pair of power-output transistors protect against thermal runaway and force each transistor to take its fair share of load current. The number of power-output transistors employed depends upon the power output required of the stage.

An R-C roll-off network is used to provide the necessary margin of stability.

4.6 D.C. POWER SUPPLY SECTION

4.6.1 GENERAL DESCRIPTION

D.C. power, of both polarities and at several voltage and current levels, is required for the various stages in the A.C. Power Supply.

$^{+}$-15, $^{+}$-5 and +12 VDC regulated is required by the oscillator and optional GPIB interface. $^{+}$-15 is required by the driver amplifier.

+60 VDC at high current levels is required by the power output stage collectors. On 350-1500 VA models this is a regulated voltage. On models up to 350 VA, or with 30/ input, this is an unregulated voltage.

A single input power transformer is used. This transformer has a sufficient number of output windings to provide A.C. voltage to the various D.C. power supplies.

4.6.2 ELECTRICAL DESCRIPTION

The $^{+}$-15 and +12 regulated voltages are derived from I.C. regulated bridge-rectifier power supplies. A.C. power for the supplies is taken from winding 7 & 8 on the power input transformer. The $^{+}$-5 regulated voltages are derived in the same manner from winding 9 & 10.

The +60 unregulated voltage is a filtered bridge-rectifier circuit taken from winding 5 & 6 on the power input transformer. On models with 30/ input a set of diode-doublers is used in the same manner, from winding 5, 6 & 7.

On 350-1500 VA models the +60 supply uses a switching regulator to improve the efficiency of the power-output stage. The +60 volts is monitored by an op-amp used as a comparator-switch. Variations in the +60 voltage cause the op-amp to turn on the switching transistors when the voltage is too low, and vice-versa. Turning on the switching transistors causes the output filter-capacitor voltage to rise as it receives current from the raw +60 supply. When the voltage rises to the correct level the comparator-switch turns off the switching transistors. Capacitor charging currents are limited by using a reactor. Flyback voltages across this reactor are also channeled into the output capacitor through a diode.

A very fast acting circuit breaker is used to monitor the power output stage collector current. If this current exceeds a predetermined value, the circuit breaker trips and removes all input power to the unit. This circuit breaker provides additional protection to that provided by the instantaneous electronic overload protection.

SECTION 5 MAINTENANCE AND CALIBRATION

SAFETY NOTE

This equipment involves the use of voltages and currents that can be hazardous. Only qualified personnel should be allowed to operate or service it.

Before performing any of the following maintenance or adjustment procedures, where access to the inside of the equipment is required, be sure to discharge the D.C. power supply filter capacitor/s. After placing the LINE circuit breaker in the OFF position use a 100 ohm, 2 watt resistor to first discharge capacitor C2 (when used) and then capacitor C1. (See chassis layout drawings for location of the capacitors.)

5.1 MAINTENANCE

5.1.1 AIR FILTERS

Air filters, when used, should be cleaned every six months, or more often if required. Metal mesh filters should be removed, cleaned in soapy water, rinsed, dried and sprayed with an appropriate filter spray. Plastic foam filters merely require cleaning with a vacuum cleaner from the outside.

5.2 ADJUSTMENTS

Before performing the following adjustments, allow the equipment to warm up for approximately one hour, with the top cover/s on and no output load.

5.2.1 DRIVER POSITIVE FEEDBACK ADJUSTMENT

With the power supply output voltage adjusted to the desired level and the output-switch in the ON position, connect a load of approprate value to the output terminals. Note the variation in output voltage as the load is connected. Adjust the positive-feedback potentiometer (R34) with the load connected so as to obtain the same output voltage as in the unloaded state, within the specifications of the unit.

5.2.2 DRIVER OVERLOAD AJUSTMENT

This adjustment should be made with the use of an oscilloscope monitoring the output voltage waveshape. Select a resistive load that will draw 120% of the unit's rated output current at 77-92% of the unit's maximum output voltage (100-120 volts on 0-130 volt unit). With the load applied to the output terminals, and the output switch in the ON position, increase the output voltage to the point at which 120% of the rated current will flow through the load. At this point the peaks of the output sinewave should just begin to clip. If this clipping onset does not occur, adjustment of the overload potentiometer (R33) should be made. The clipping level is designed to vary somewhat with temperature, so as to limit the output to lower levels at higher temperatures.

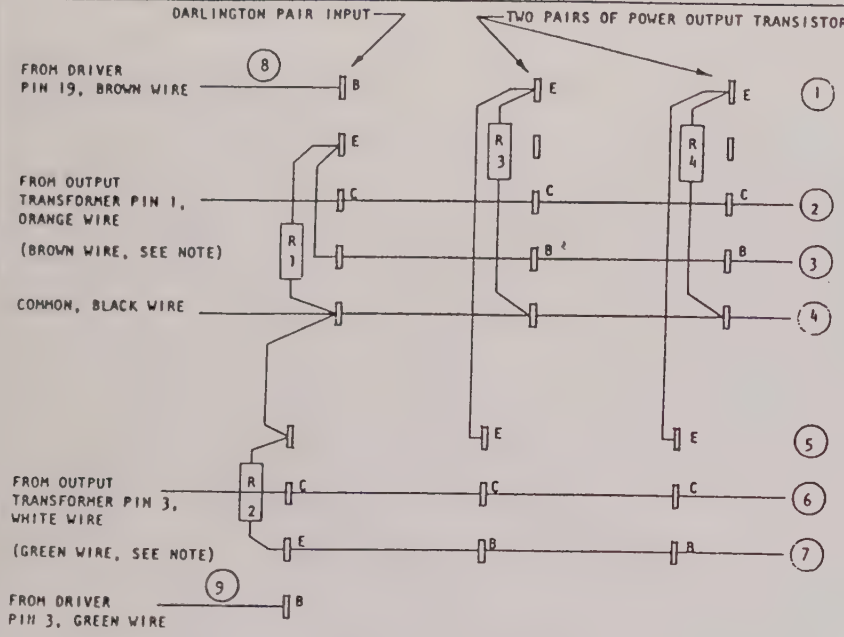
If an oscilloscope is not available the above adjustment can be made by connecting the appropriate load, increasing the output voltage, and observing the point at which this voltage drops off. This provides an indication of the onset of clipping.

NOTE

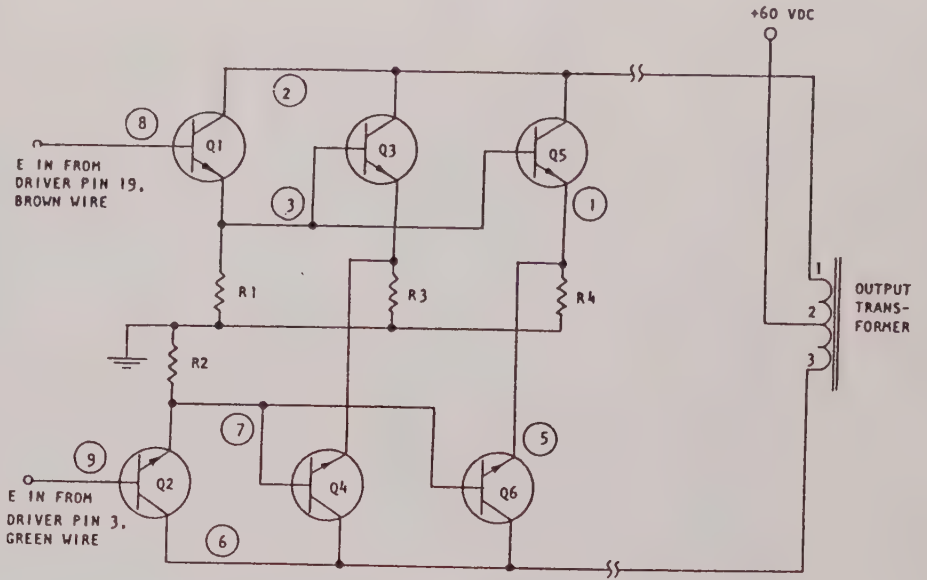
On multi-phase models (wye or delta outputs) make the above adjustments on one phase and then proceed to the next. On delta output models a neutral output-terminal is provided for connecting the test loads from line-neutral rather than line-line. If this is not done, making an adjustment on one phase will effect the other phase/s and vice versa. Be sure to use line-neutral, not line-line, specifications.

5.3 TROUBLESHOOTING

If the LINE circuit breaker trips, and cannot be reset, the most likely problem is a defective power output stage transistor. Refer to Troubleshooting Procedure drawing.



LOOKING ON TOP OF THE TERMINAL STRIPS OF A TYPICAL POWER OUTPUT STAGE.



CORRESPONDING SCHEMATIC OF COMPONENT LAYOUT SHOWN AT LEFT.

TROUBLESHOOTING PROCEDURE.

1. Defective darlington input transistors. Check B-E, B-C, E-C of Q1 and Q2 with ohmmeter.
2. Connect an ohmmeter* between (1) and (2), and then between (5) and (6). One way reads high, the other low (e.g., from collector through base, R1 and R4.) However, if one output stage consists of two stacks and each stack is located in a different chassis and the cable between chassis is disconnected, then the stack not having the darlington pair will read high both ways between (1) and (2), and (5) and (6). Without interconnecting cable ground connections may be open.
3. Collector to emitter short. Determine if the short is between (2) and (1) or (6) and (5). Connect one ohmmeter lead to the collector buswire and the other lead to each emitter, in turn. Read approx. 1 to 2 ohms. A lower reading indicates the defective transistor. Check both directions, see step 2.
4. Collector to base short. Determine if the short is between (2) and (3) or (6) and (7). (The ohmmeter reads low both ways.) Start cutting the base buswire from each base connection (3) or (7) until the defective transistor is isolated.
5. Emitter to base short. Determine if the short is between (3) and (1) or (7) and (5). It may help to lift the base buswire from R1 and/or R2. Connect one ohmmeter lead to the base buswire (3) or (7) and the other to each emitter, in turn. Since the meter reads through the emitter resistor of a good stage, the shorted transistor will have a near zero reading.

NOTE:

R1 & R2 can be 2 ohm, 1 ohm, or 1 ohm paralleled by 5.1 ohm, depending on number of output transistors. R3 and R4 are 0.5 ohm. The bases (7) & (3) may have green and brown wires, respectively, connected to them. These are interconnecting wires if an output stage consists of two or more individual stacks, but only one darlington pair.

(1) Refers to test points.

Steps 2 to 5 of the troubleshooting procedure refer to power output transistors Q3-4-5-6-.

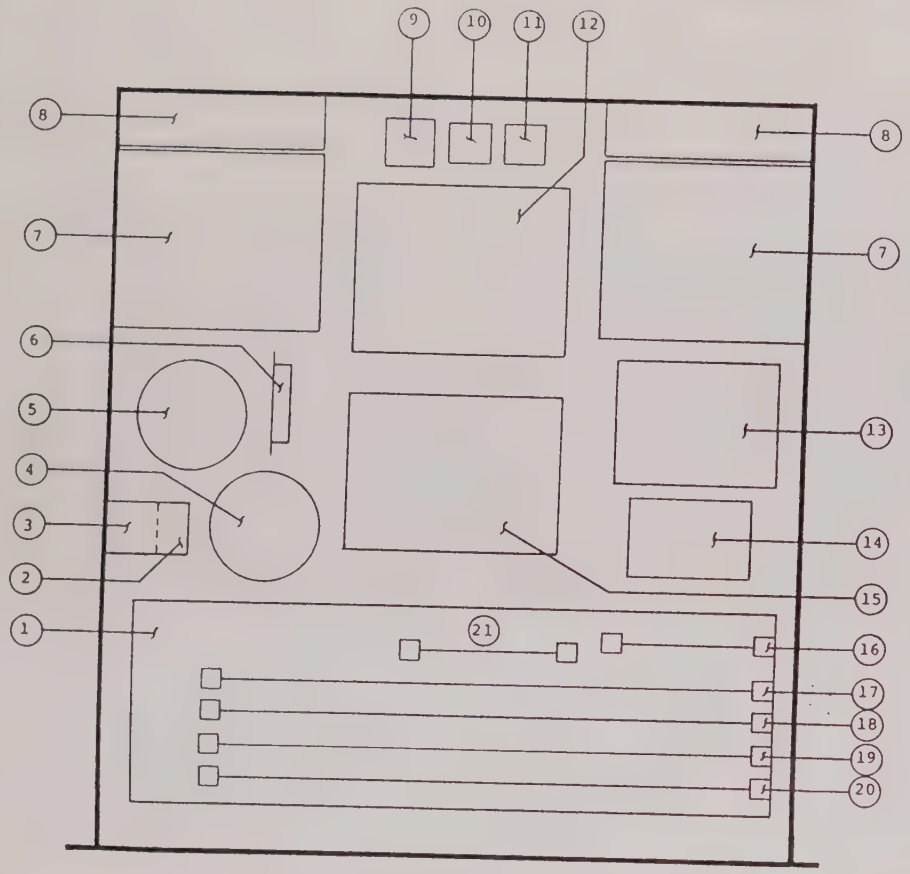
*Use an analog meter such as the Simpson 260 or 269, or the Triplett 630A.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY WH	APPROVED BY
DATE 8/3/81	REVISED
TITLE TROUBLESHOOTING PROCEDURE FOR POWER OUTPUT STAGE	
MODEL	DRAWING NO. B-1395

SECTION 6 SCHEMATICS AND PARTS LISTS

MODEL KBT-50-C-SZ76

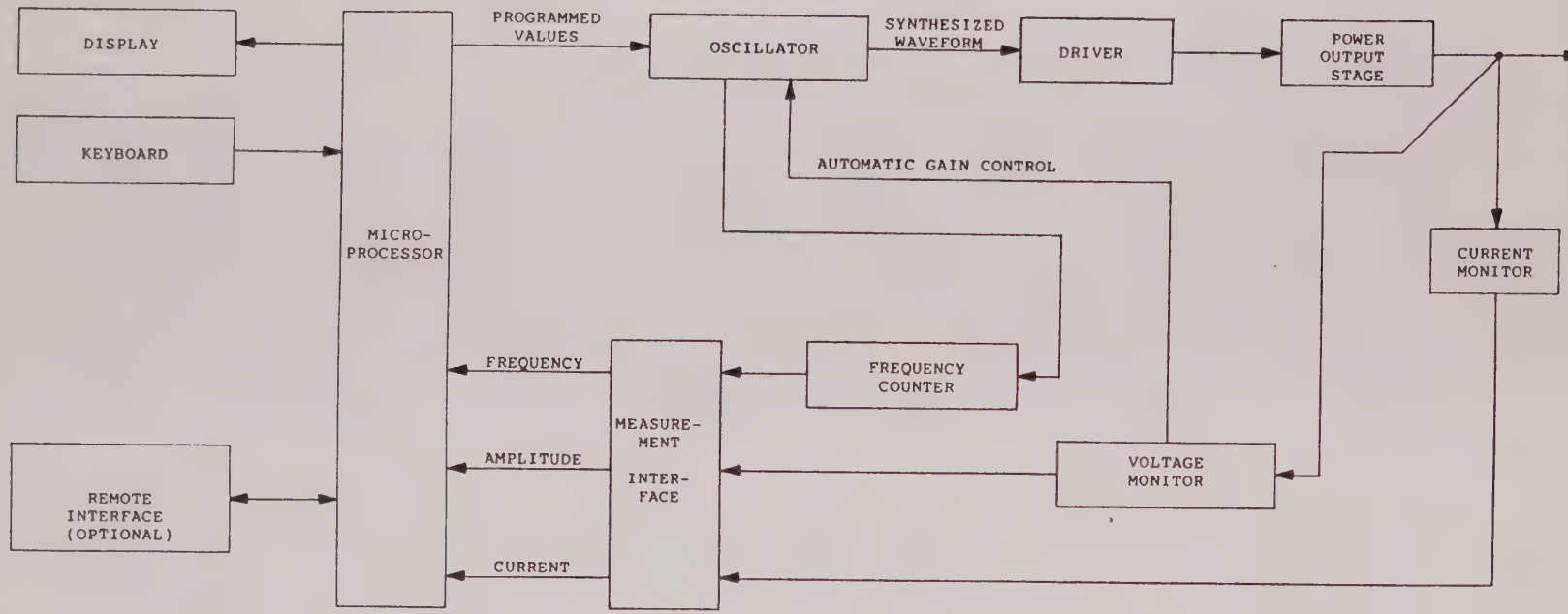
DESCRIPTION	ASSY NO.	SCHEMATIC DWG. NO.	COMPONENT. LAYOUT NO.
CHASSIS LAYOUT	-	-	B-2139
BLOCK DIAGRAM	-	-	B-2105
FRONT PANEL-CONTROL CIRCUITS		B-2143	-
MOTHER BOARD	16-190	C-1004	B-2150
MICROPROCESSOR CARD	16-141	B-1878	B-1879
FREQUENCY CARD	16-194	B-2075	B-2076
MEASUREMENT CARD	16-189	B-1868	B-2050
VOLTAGE CARD	16-179	B-1859	B-2037
DRIVER	DR-9	B-1274	B-1219
POWER OUTPUT STAGE	-	B-2097/A	-
DC POWER SUPPLY	-	B-2138	-
DC POWER SUPPLY CARD (REG.)	16-173	B-2024	B-2025



ITEM #	DESCRIPTION	SYMBOL	DWG. NO.
1	MOTHER BOARD	ASSY 16-190	C-1004
2	RELAY	K2	B-2097
3	RELAY (CHASSIS MOUNT)	K1	B-2097
4	CAPACITOR	C2	B-2138
5	CAPACITOR	C1	B-2138
6	COLLECTOR ROLL-OFF	ASSY 16-009	B-2097
7	TRANSISTORS (POWER OUTPUT)	Q1-16	B-2097
8	FANS (COOLING)	B1,2	B-2138
9	BRIDGE RECTIFIER	BR1	B-2138
10	BRIDGE RECTIFIER	BR2	B-2138
11	BRIDGE RECTIFIER	BR1	B-2097
12	TRANSFORMER (POWER INPUT)	T1	B-2138
13	TRANSISTORS (+60 REGULATOR)	Q2-6	B-2138
14	REACTOR	L1	B-2138
15	TRANSFORMER (POWER OUTPUT)	T1	B-2097
16	POWER SUPPLY CARD	ASSY 16-173	B-2024
17	VOLTAGE CARD	ASSY 16-179	B-1859
18	MEASUREMENT CARD	ASSY 16-189	B-1868
19	FREQUENCY CARD	ASSY 16-194	B-2075
20	MICROPROCESSOR	ASSY 16-141	B-1878
21	DRIVER	DR-9	B-1274

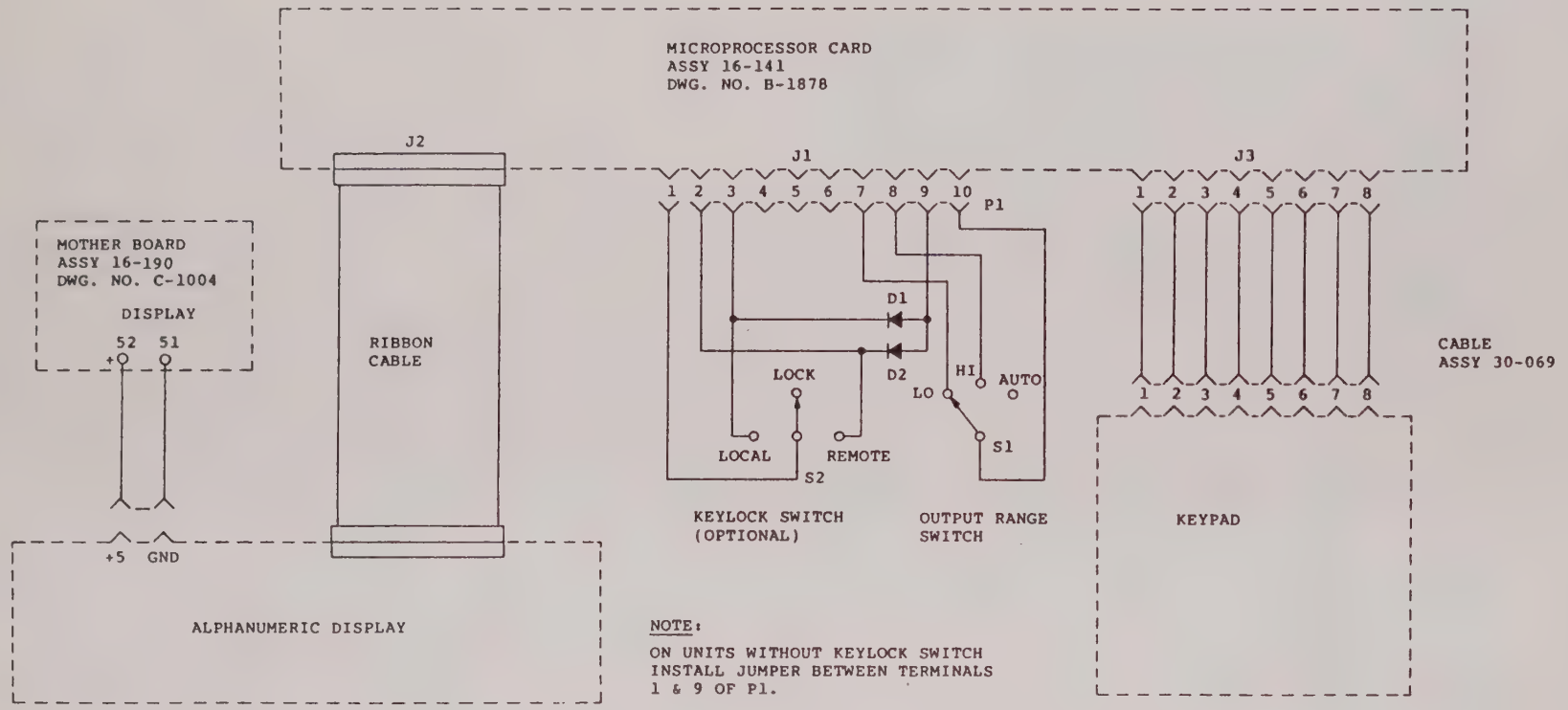
Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY PS	APPROVED BY
DATE 3/9/84	REVISED
TITLE CHASSIS LAYOUT	
MODEL KBT-50-A/C	DRAWING NO B-2139/A

BISHOP GRAPHICS/ACCUPRESS
REORDER NO A11215



Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY PLK	APPROVED BY Jay F. Kitt
DATE 2/20/84	REVISED
TITLE BLOCK DIAGRAM	
MODEL KBT-	DRAWING NO. B-2105

BISHOP GRAPHICS/ACCUPRESS
REORDER NO. A11215



NOTE:

ON UNITS WITHOUT KEYLOCK SWITCH INSTALL JUMPER BETWEEN TERMINALS 1 & 9 OF P1.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY WH	APPROVED BY
DATE 3/13/84	REVISED
TITLE FRONT PANEL CONTROL CIRCUITS	
MODEL KEYBOARD, 10	DRAWING NO. B-2143

BISHOP GRAPHICS/ACCUPRESS
REORDER NO A11215

PARTS LIST

Description FRONT PANEL
CONTROL CIRCUITS SINGLE PHASE
Assembly/part no.
Drawing/ref no. B-2143

Model KBT-

Page 1 of 1

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
D1,2	Diode 20mA, 100V	IN914A	TI
P1	Connector, Square pin Single row, 10 contact	121-7356-010	Cannon
S1	Switch, Rotary 3 pole, 2-5 position Non-shorting	PA-2007	Centralab
S2	Switch, Keylock	5-51115-601	Oakswitch
1pc	Alphanumeric Display 40 characters	3637	Chemetrics
1pc	keypad	NK0488	Digitran

PARTS LIST

Description MOTHER BOARD
SINGLE PHASE
Assembly/part no. 16-190
Drawing/ref no. C-1004, B-2051/A

Model KBT-

Page 1 of 2

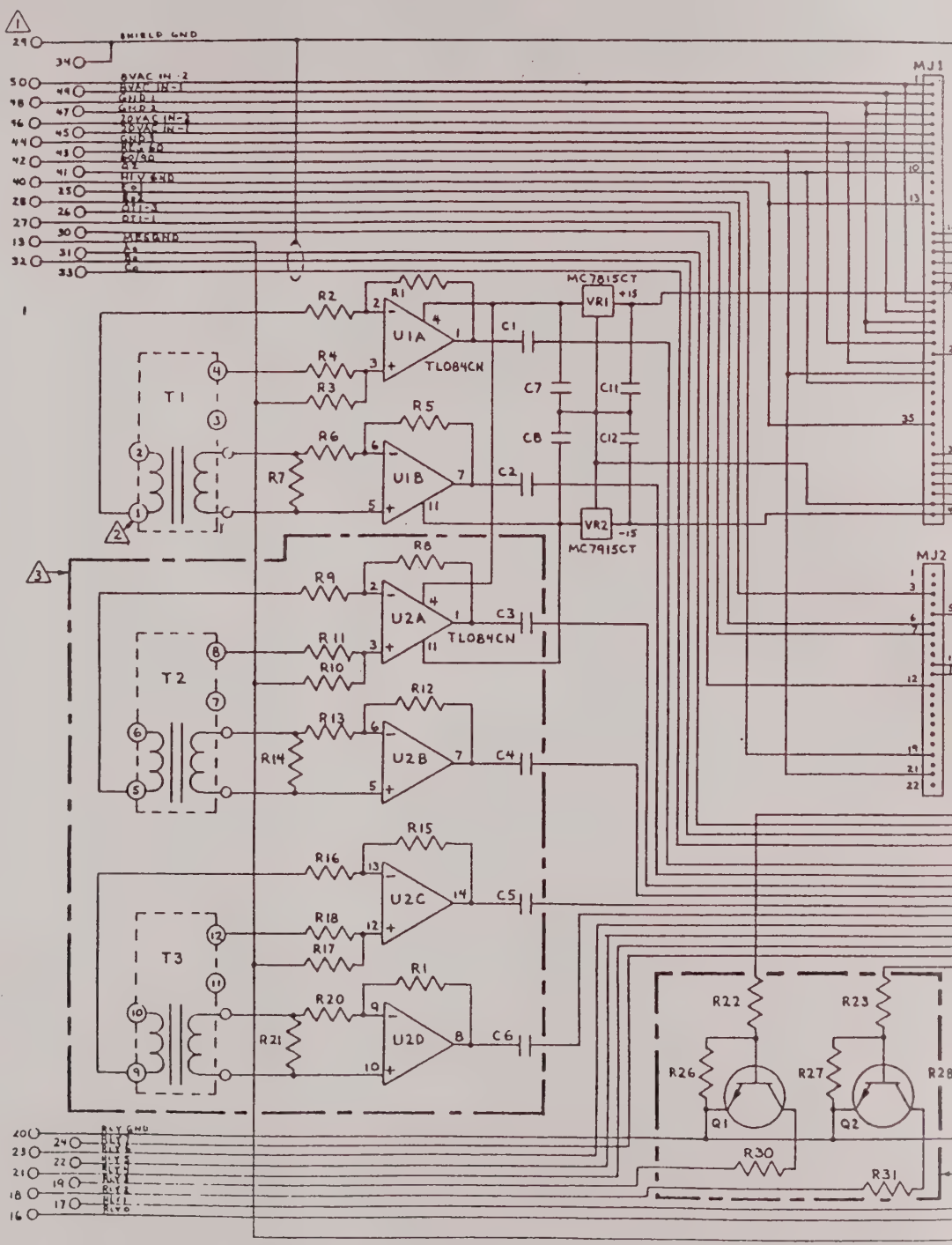
REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1,2,7,8 11,12	Capacitor, Monolythic 2.2uF, 50V	3C37Z5U225M05B	Sprague
C3-6	Not used		
C9,10	Capacitor, Tantalum 10uF, 25V	1993106X0025CAT	Sprague
MJ1,2	Card edge connector 22 contact	50-44B-10	TRW
MJ3	Cable header 26 contact	65593-136	Berg
MJ4-7	Card edge connector 50 dual contacts	R681-2	Vector
MJ8	Not used		
Q1,2	Not used		
Q3,4	Transistor, NPN	2N3440	Motorola
R1,3	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R2,4	Resistor, Metal film 750K, 1/4W, 1%	RN55D 7503F	
R5	Resistor, Metal film 4.99K, 1/4W, 1%	RN55D 4991F	
R6,28,29	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
R7	Resistor, Wire wound 1 ohm, 3W	RW69V1R0	Dale
R8-23 26,27,30,31	Not used		
R24,25	Resistor, Metal film 499 ohm, 1/4W, 1%	RN55D 4990F	
R32,33	Resistor, Wirewound. 1K, 3W	RW69 V102	Dale

PARTS LIST

Description MOTHER BOARD
SINGLE PHASE
Assembly/part no. 16-190
Drawing/ref no. C-1004, B-2051/A

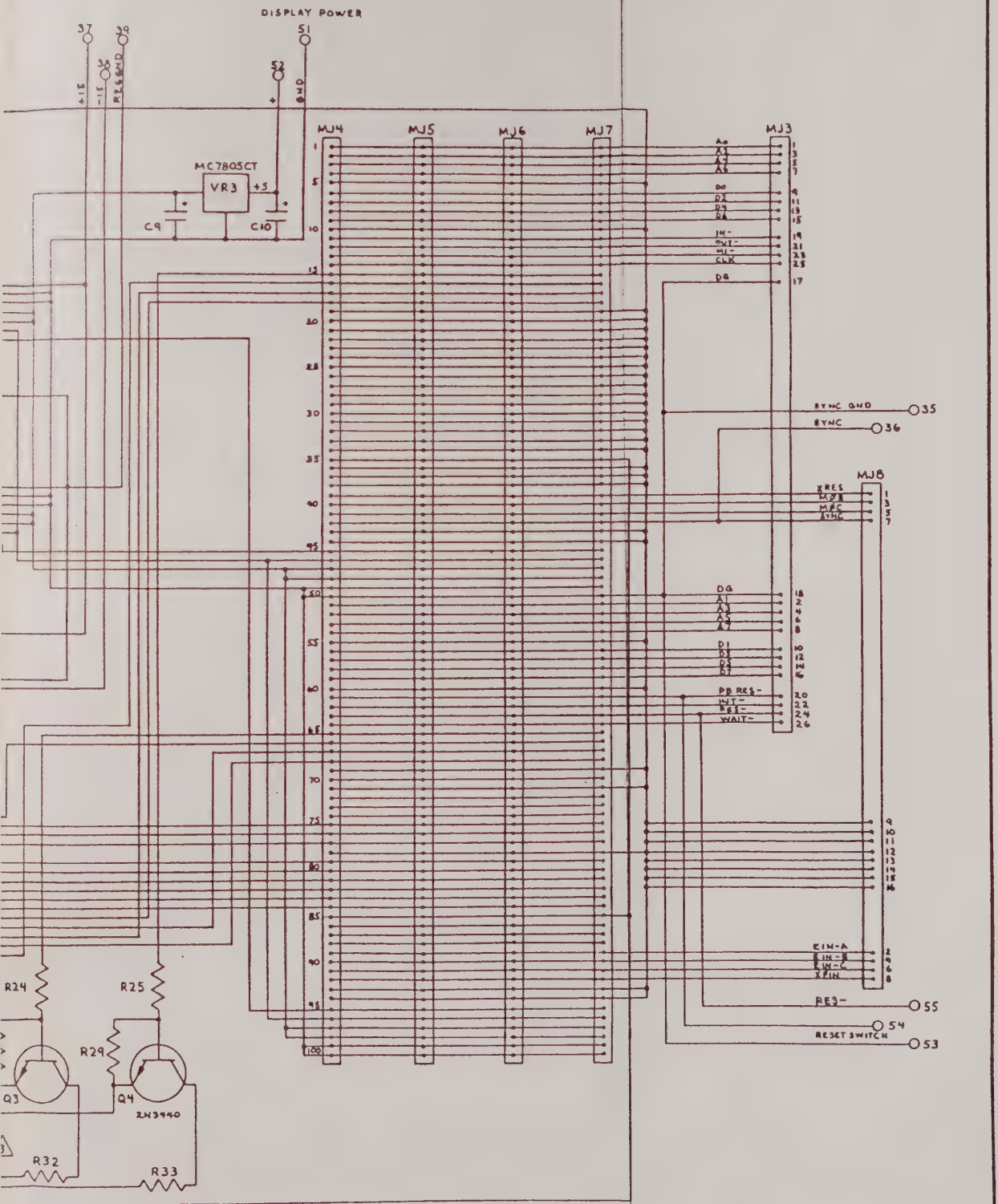
Model KBT-

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
T1	Transformer, Toroid Secondary: 100T #26 Primary: 100VA: 33T #24 250VA: 20T #20 350VA: 14T #18 500VA: 10T #18 750VA: 6T #16 1000VA: 10T #16 1500VA: 7T #14 2000VA: 5T #14 3000VA: 3T #12		Behlman Eng.
T2,3	Not used		
U1	Quad Operational amplifier	TL084CN	TI
U2	Not used		
VR1	Voltage regulator +15V, 1.5A	MC7815CT	Motorola
VR2	Voltage regulator -15V, 1.5A	MC7915CT	Motorola
VR3	Voltage regulator +5V, 1.5A	MC7805CT	Motorola
1pc	Heat sink	6070B	Thermalloy
8pcs	Card guide	RAD-4125	Unitrack
8pcs	Card guide bracket	VM-7500	Unitrack
4pcs	Card guide	50-GP-1	Cinch
47pcs	Bifurcated terminals	2021C	Useco
1pc	Printed circuit board	15-076/B	Behlman Eng.

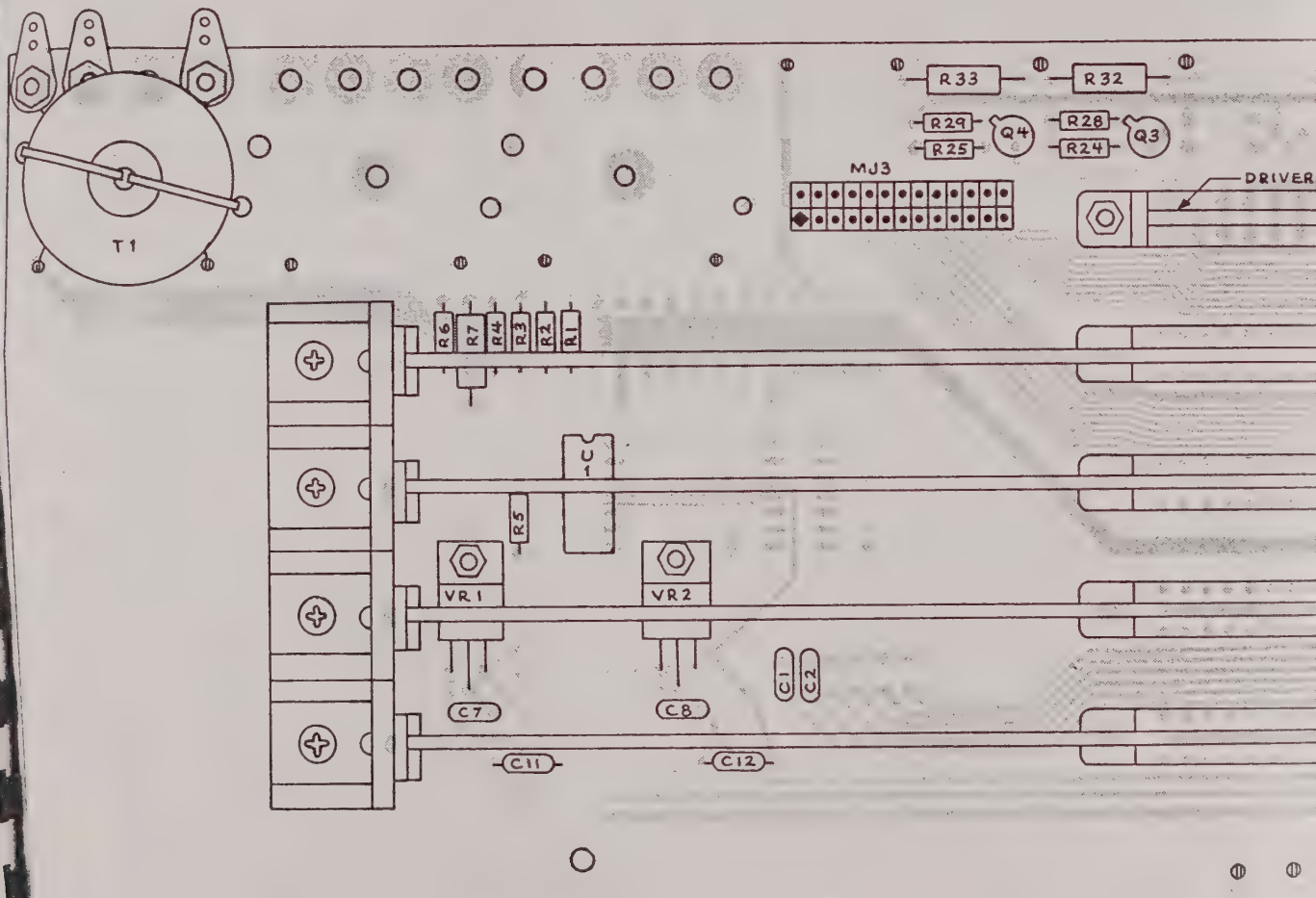


NOTES:

1. BIFURCATED TERMINAL NUMBER (TYP.)
2. SOLDER LUG NUMBER (TYP.)
3. BLOCKED IN SECTION REQUIRED FOR PCB ASSY 16-149 (3 PHASE) ONLY.

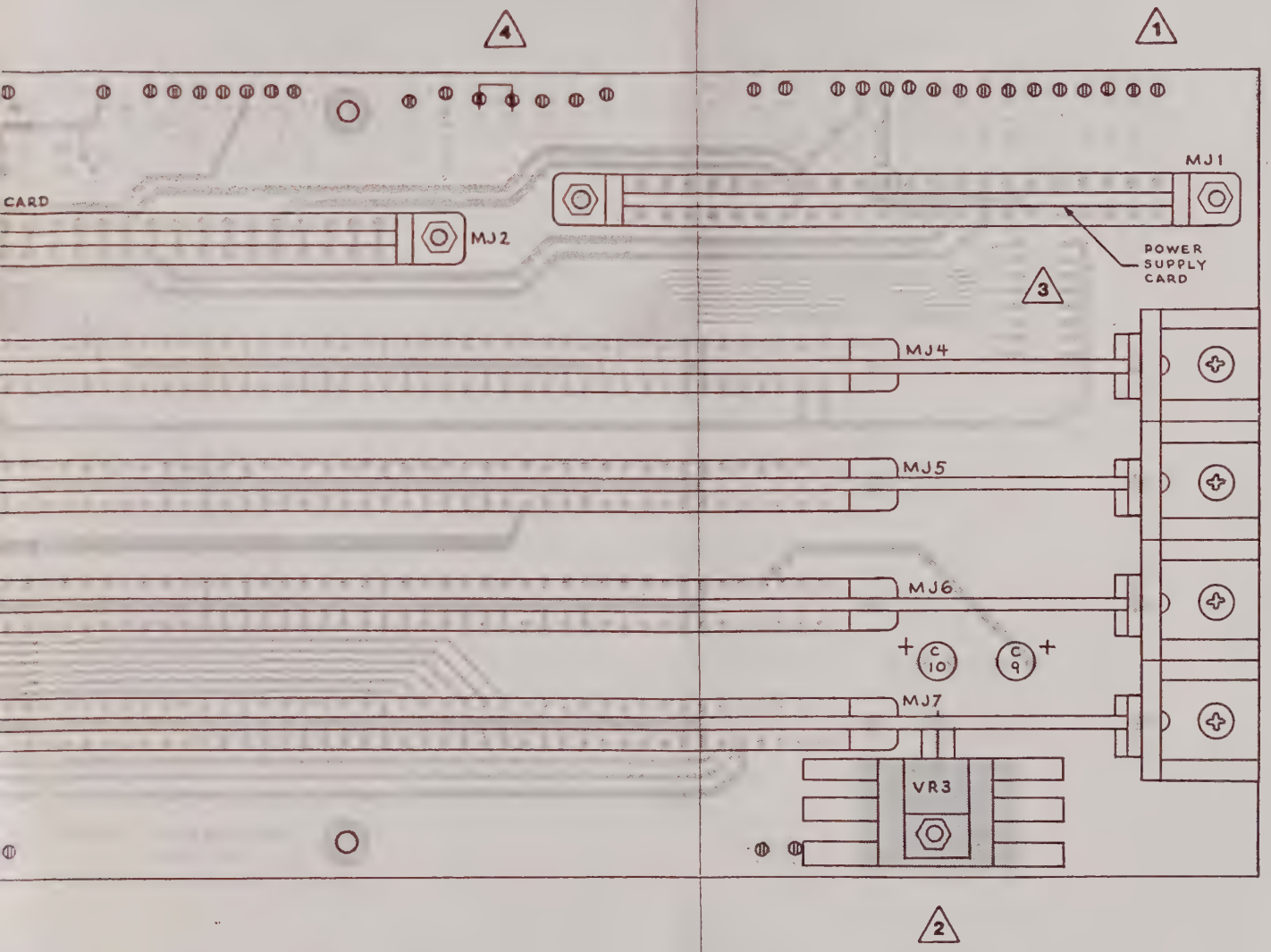


BEHLMAN ENGINEERING CORP. SANTA BARBARA, CALIF.		
SCALE ~	APPROVED BY Gary T. Killion	DRAWN BY R.KOCH
DATE 2-16-84		REVISED
MOTHER BOARD CIRCUIT		
PCB ASSY 16-190 (1 PHASE) PCB ASSY 16-149 (3 PHASE)		DRAWING NUMBER C-1004



NOTES:

1. BIFURCATED TERMINALS (47 PLACES)
   PRESS FIT WITH SLOTS 90° TO PCB EDGE.
2. INSTALL 6070B HEAT SINK WITH THERMALCOTE #251
   THERMAL JOINT COMPOUND OR EQUIVALENT.
3. PROVISION FOR DIP SOCKET MJ8 WHEN REQUIRED.
4. JUMPER TERMINALS 30 & 31 (22 AWG BUSS)



BOTTOMPLATE	
NEXT ASSY	USED ON
APPLICATION	

Behlman Engineering Corp
SANTA BARBARA, CALIFORNIA

DRAWN BY P.L.KOCH		APPROVED BY
DATE 6-1-84		SCHEMATIC: C-1004
TITLE SINGLE PHASE MOTHER BOARD		
ASSY NO. 16-190	DRAWING NO. B-2051	REV A

PARTS LIST

Description MICROPROCESSOR CARD

Model KBT-

Assembly/part no. 16-141
Drawing/ref no. B-1878, B-1879

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1	Capacitor,dipped mica 100pF, 500V	CM05FD101J03	CDE
C2,5-8,11	Capacitor, Tantalum 10uF, 25V	199D106X0025CB1	Sprague
C3,12-22	Capacitor, Monolythic 0.1uF 50V	SR205E104MAA	AVX
C4	Capacitor, Monolythic 2.2uF, 50V	3C37Z5U225M05B	Sprague
C9,10	Capacitor, Dipped mica 33pF, 500V	CM05ED330J03	CDE
D1	Diode 20mA, 100V	1N914A	TI
J1	Connector Single row, 10 contact	65593-110	Berg
J2	Connector, 90° male Double row, 26 contact	609-2607	Ansley
J3	Connector Single row, 9 contact	65593-109	Berg
Q1	Transistor, PNP	2N3906	Motorola
Q2	Transistor, PNP	2N3904	Motorola
R1-4	Resistor, Metal film 2.21K, 1/4W, 1%	RN55D 2211F	
R5,6, 9,11,12,15	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
R8	Resistor, Metal film 100K, 1/4W, 1%	RN55D 1003F	
R10	Resistor, Network 5.6K, SIP	4310R-101-562	Bourns
R13	Not used		

PARTS LIST

Description MICROPROCESSOR CARD

Model KBT-

Assembly/part no. 16-141

Drawing/ref no. B-1878, B-1879

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R14	Resistor, Metal film 1.24K, 1/4W, 1%	RN55D 1241F	
R16,17	Resistor, Metal film 261 ohm, 1/4W, 1%	RN55D 2610F	
TP1-8	Test point Single contact	65593-101	Berg
TS1-3	Test strip 8 contact	65593-108	Berg
U1,18	Hex buffer, Tri-state	74LS367	Motorola
U2,5	Hex Inverter	74LS14	Motorola
U3,17	Dual D-type Flip-Flop	74LS74	Motorola
U4,21	Quad NAND gate 2 Input	74LS00	Motorola
U6	Microprocessor	Z80	Zilog
U7,8,24	Octal Line driver	74LS244	Motorola
U9,23	Octal Bus transceiver	74LS245	Motorola
U10,11	EPROM memory	D2732A	Intel
U12	Not used		
U13,14	MOS Ram, 4 Bit	MCM2114P30	Motorola
U15,19,20	BCD decoder	74LS42	Motorola
U16	Keyboard encoder, 20 Key	74C923	National
U22	Octal D-type Flip-Flop, Tri-state	74LS374	Motorola
VR1,2	Voltage regulator +5V, 1.5A	MC7805CT	Motorola

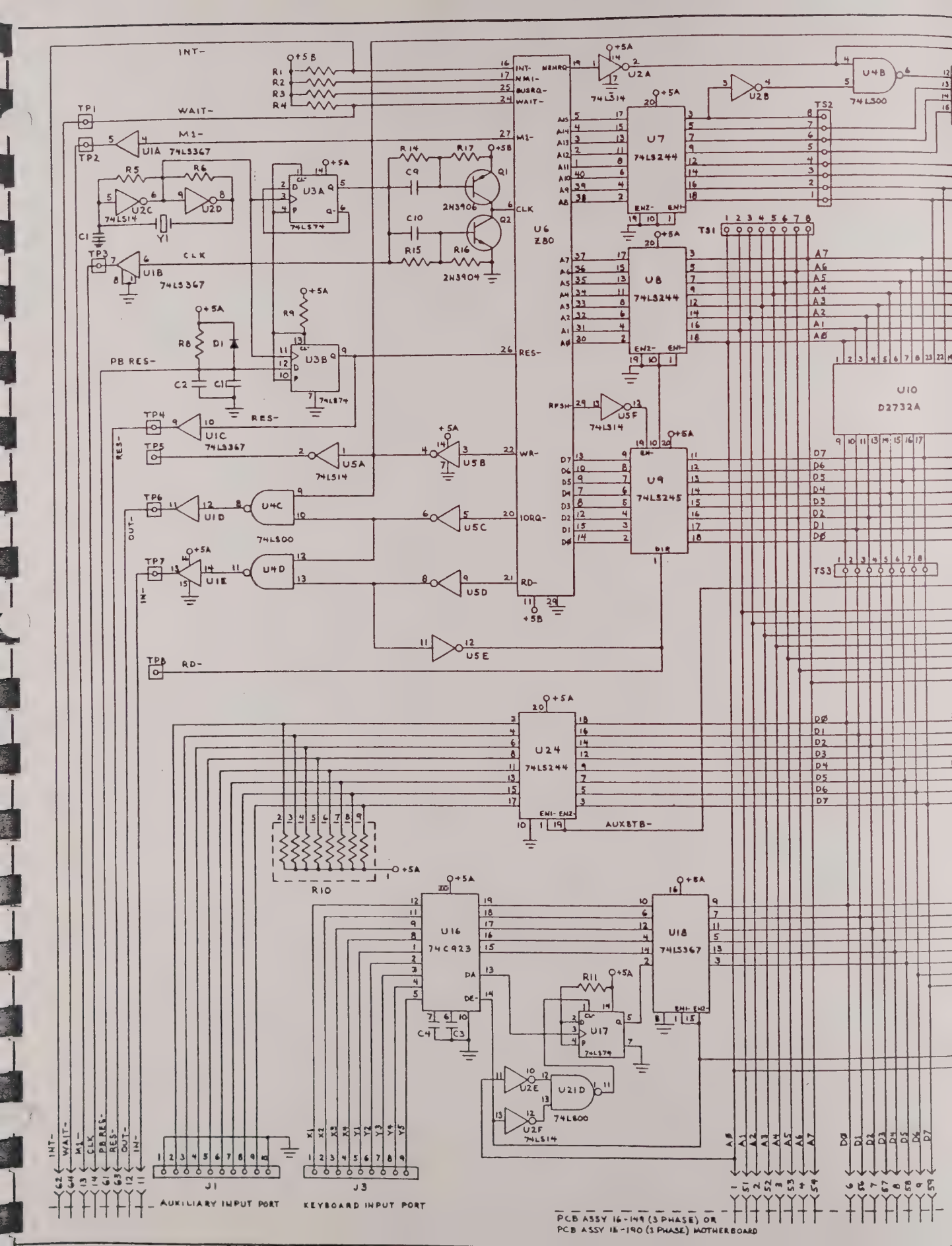
PARTS LIST

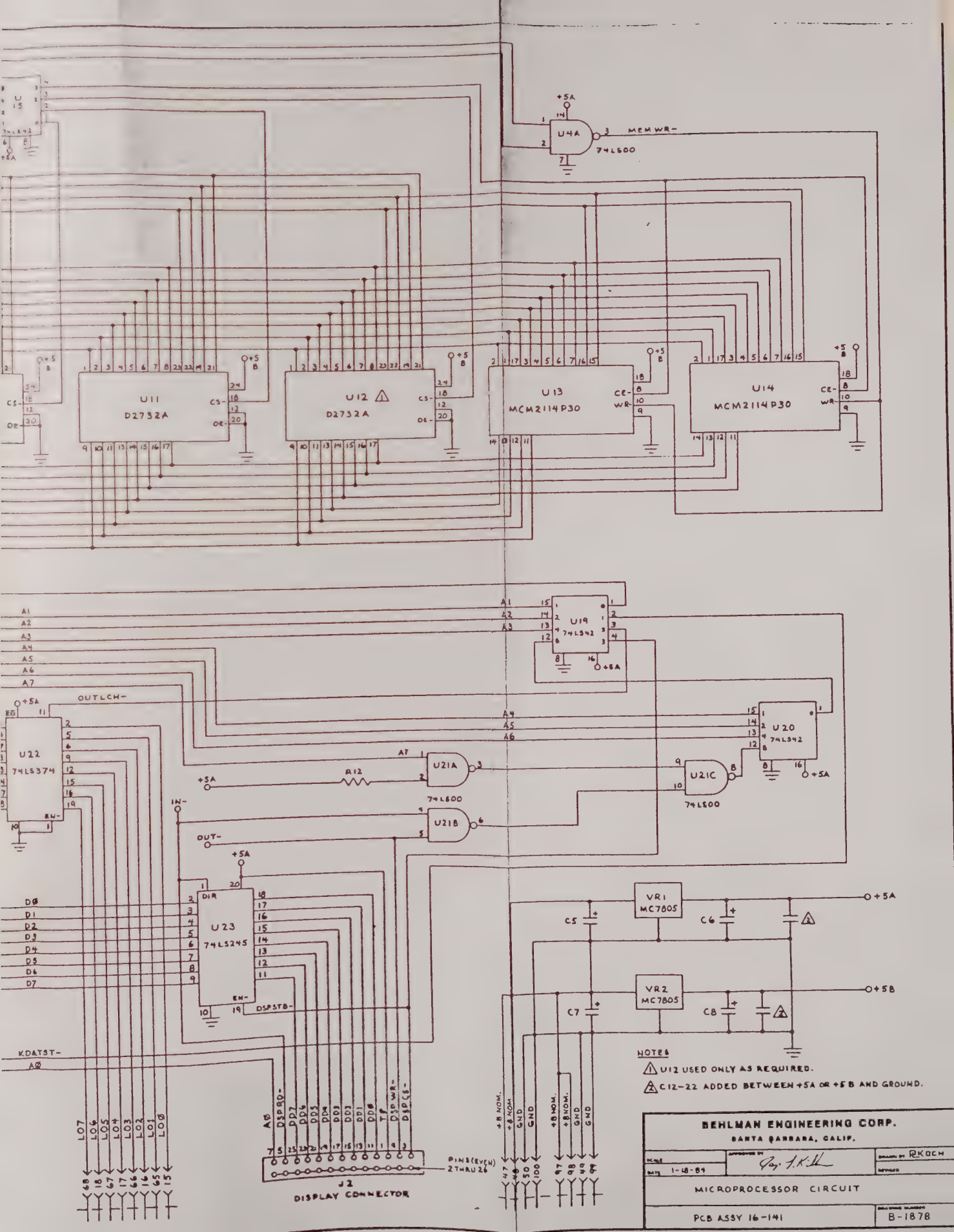
Description MICROPROCESSOR CARD

Model KBT-

Assembly/part no. 16-141
Drawing/ref no. B-1878, B-1879

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
Y1	Crystal, 4.00 MHz	CY3A	Crystek
2pcs	IC Socket 18 contact	18S-TSD	CA
1pc	IC Socket 20 contact	B0005	Dow
2pcs	IC Socket 24 contact	24S-TSD	CA
1pc	IC Socket 40 contact	40S-TSD	
2pcs	Heat sink	6070B	Thermalloy
1pc	Printed circuit board	15-073/A	Behlman Eng.


INT-
WAIT-
M1-
CLK
PB RES-
RES-
OUT-
IN-
RD-
+5B
+5A
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R14
R15
R16
R17
C1
C2
C3
C4
C9
C10
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
Y1
Q1
Q2
D1
U1A 74LS367
U1B 74LS367
U1C 74LS367
U1D
U1E
U2A 74LS14
U2B
U2C 74LS14
U2D
U2E
U2F 74LS14
U3A 74LS74
U3B 74LS74
U4B 74LS00
U4C 74LS00
U4D
U5A 74LS14
U5B
U5C
U5D
U5E
U5F 74LS14
U6 Z80
U7 74LS244
U8 74LS244
U9 74LS245
U10 D2732A
U16 74C923
U17 74LS74
U18 74LS367
U21D 74LS00
U24 74LS244
2N3906
2N3904
NMIRQ
BUSRQ-
WAIT-
M1-
RES-
WR-
IORQ-
RD-
RFSH-
A0
A1
A2
A3
A4
A5
A6
A7
D0
D1
D2
D3
D4
D5
D6
D7
TS1
TS2
TS3
AUXBTB-
J1
J3
AUXILIARY INPUT PORT
KEYBOARD INPUT PORT
PCB ASSY 16-149 (3 PHASE) OR
PCB ASSY 18-190 (3 PHASE) MOTHERBOARD



NOTES

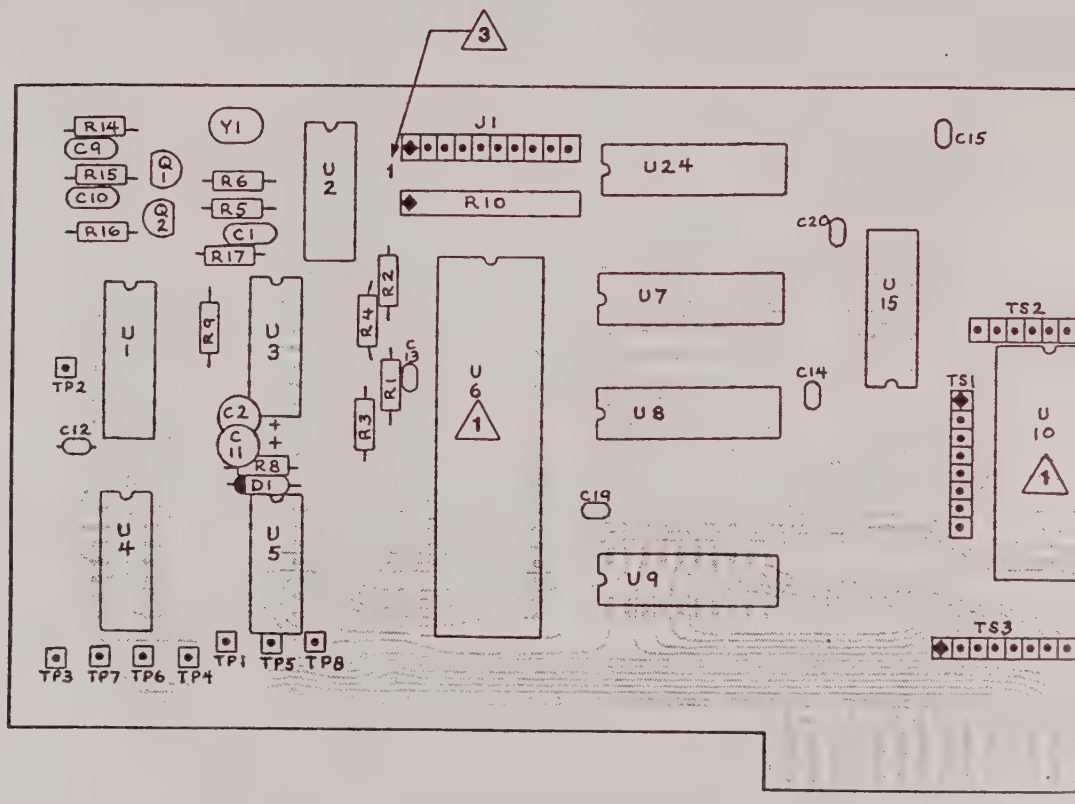
1. U12 USED ONLY AS REQUIRED.
2. C12–22 ADDED BETWEEN +5A OR +5B AND GROUND.

BEHLMAN ENGINEERING CORP.
SANTA BARBARA, CALIF.

	APPROVED BY	DRAWN BY RKOCH
DATE 1-18-84		DETAILED

MICROPROCESSOR CIRCUIT

PCB ASSY 16-141 — DRAWING NUMBER B-1878



1

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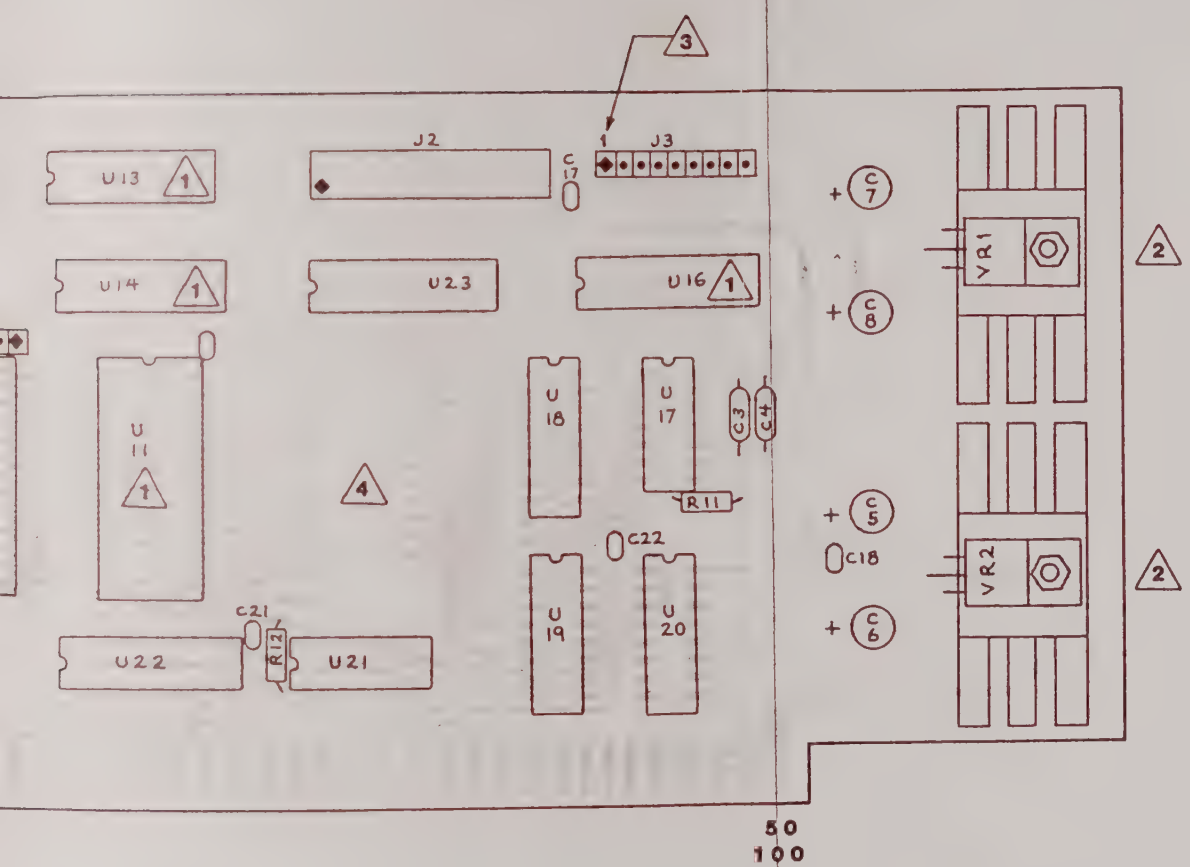
NOTES:

1. SOCKETS REQUIRED.
2. INSTALL 6070B HEAT SINK WITH THERMALCOTE #251 THERMAL JOINT COMPOUND OR EQUIVALENT.
3. TRANSFER NUMBER "1" (BLACK) AT THIS LOCATION.
4. PROVISION FOR U12 WHEN REQUIRED.



16-149 OR 16-190	
NEXT ASSY	USED ON
APPLICATION	

Behlman Engineering Corp
SANTA BARBARA, CALIFORNIA

DRAWN BY P.L.KOCH	APPROVED BY
DATE 6-1-84	SCHEMATIC: B-1878
TITLE MICROPROCESSOR CARD	
ASSY NO. 16-141	DRAWING NO. B-1879 / REV

PARTS LIST

Description DIGITAL FREQUENCY CARD

Model KBT-

Assembly/part no. 16-194/A

Drawing/ref no. B-2075/A, B-2076/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1-9,11,12 18,27,29-31	Capacitor, Monolythic .1uF, 50V	SR20SE104MAA	AVX
C10,13, C20,22,23, 26,28,32,33	Capacitor, Tantalum 10uF, 25V	199D10620025CB1	Sprague
C14-16	Capacitor, Monolythic 2.2uF, 50V	3C37Z5U225M050B	Sprague
C17	Capacitor, Mica 470pF, 500V	CM05FD471J03	CDE
C19	Capacitor, Mica 15pF, 500V	CM0SED150J03	CDE
C21	Capacitor, Mica 56pF, 500V	CM0SED560J03	CDE
C24	Capacitor, Monolythic 1.0uF, 50V	2C37Z5U105M050B	Sprague
C25	Capacitor, Disk .01uF, 100V	TG-510	Sprague
C34	Capacitor, Trimming Cermet, 670pF	GKF70000	Sprague
C35	Capacitor Mica 10pF, 500V	CMOSED100J03	CDE
D1-8	Diode 20mA, 100V	IN914A	ITT
J1	Connector, Male Header, 34 Contact	609-3407	Ansley
J2	Connector, Male Header, 26 Contact	609-2607	Ansley
R1	Resistor Network SIP, 10 pin, 5.6K	4310R-101-562	Bourns

PARTS LIST

Description DIGITAL FREQUENCY CARD Model KBT-

Assembly/part no. 16-194/A Page 2 of 4
Drawing/ref no. B-2075/A, B-2076/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R2,3,7,9,10 18,27,32	Resistor, Metal Film 10K, 1/4W, 1%	RN55D 1002F	Mepco
R4,5	Resistor, Metal Film 1K, 1/4W, 1%	RN55D 1001F	Mepco
R6,30	Resistor, Metal Film 1M ohm, 1/4W, 1%	RN55D 1004F	
R8,16	Resistor, Metal Film 2.21K, 1/4W, 1%	RN55D 2211F	
R11,13,28	Resistor, Metal Film 100K, 1/4W, 1%	RN55D 1003F	
R12,15,21	Resistor, Metal Film 4.75K, 1/4W, 1%	RN55D 4751F	
R14,17,31	Resistor, Carbon Comp 22M ohm, 1/4W	RC07GF206J	Allen
R19,22	Potentiometer, Trimming 20 Turn, 25K	89 PR25K	Beckman
R20	Resistor, Metal Film 20K, 1/4W, 1%	RN55D 2002F	
R23	Resistor, Metal Film 8.25K, 1/4W, 1%	RN55D 8251F	
R24	Resistor, Metal Film 110K, 1/4W, 1%	RN55D 1103F	
R25	Resistor, Metal Film 7.5K, 1/4W, 1%	RN55D 7501F	
R26	Resistor, Metal Film 30K, 1/4W, 1%	RN55D 3002F	
R29	Resistor, Metal Film 6.34K, 1/4W, 1%	RN55D 6341F	

PARTS LIST

Description DIGITAL FREQUENCY CARD

Model KBT-

Assembly/part no. 16-194/A

Drawing/ref no. B-2075/A, B-2076/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R33	Resistor, Metal Film 332 ohm, 1/4W, 1%	RN55D 3320F	
R34	Resistor, Metal film 499 ohm, 1/4W, 1%	RN55D 4990F	
U1	Octal Buffer/Driver	SN75160	Motorola
U2	Octal Buffer/Driver	SN75161	Motorola
U3	IEEE-488 Interface	TMS 9914ANL	TI
U4,11,19	Hex Buffer Tri-State	74LS367	Motorola
U5,7,9	Octal Bus Transceiver	74LS245	Motorola
U6,16	Quad 2 Input OR gate	74LS32	Motorola
U8,10	Programmable Peripheral Interface	AM8255A	AMD
U12,14	BCD to Decimal Decoder	74LS42	Motorola
U13	Decade Counter Divide by 5 & 2	74LS90	TI
U15	Quad 2 Input NAND gate	74LS00	Motorola
U17,20,21 23,24	Decade Rate Multiplier	74167	TI
U18	D-Type Latch 4-Bit	74LS75	Motorola
U22	Dual Voltage Controlled Oscillator	74S124	TI
U25,27	Hex Buffer Non-Inverting	CD4050AE	RCA

PARTS LIST

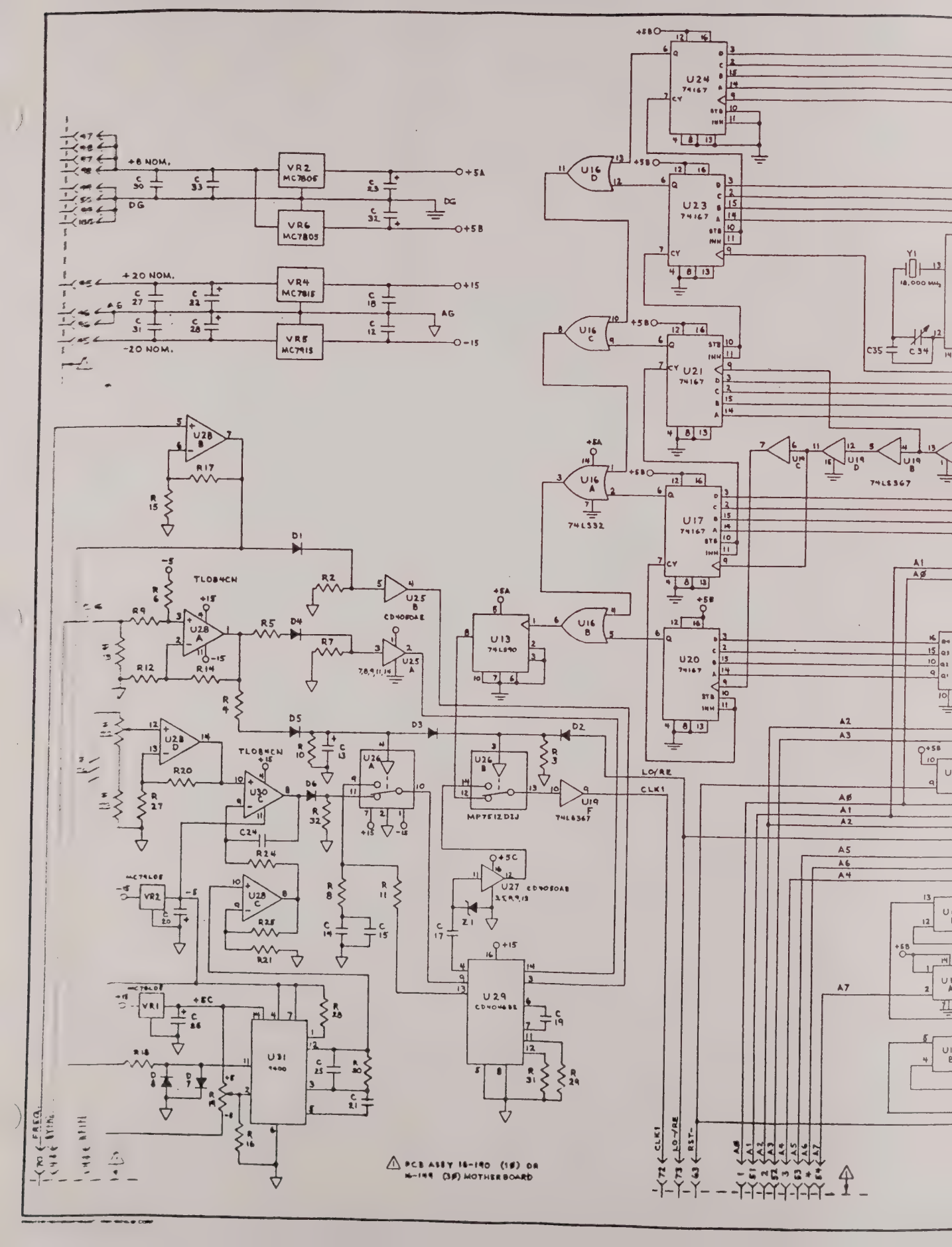
Description DIGITAL FREQUENCY CARD

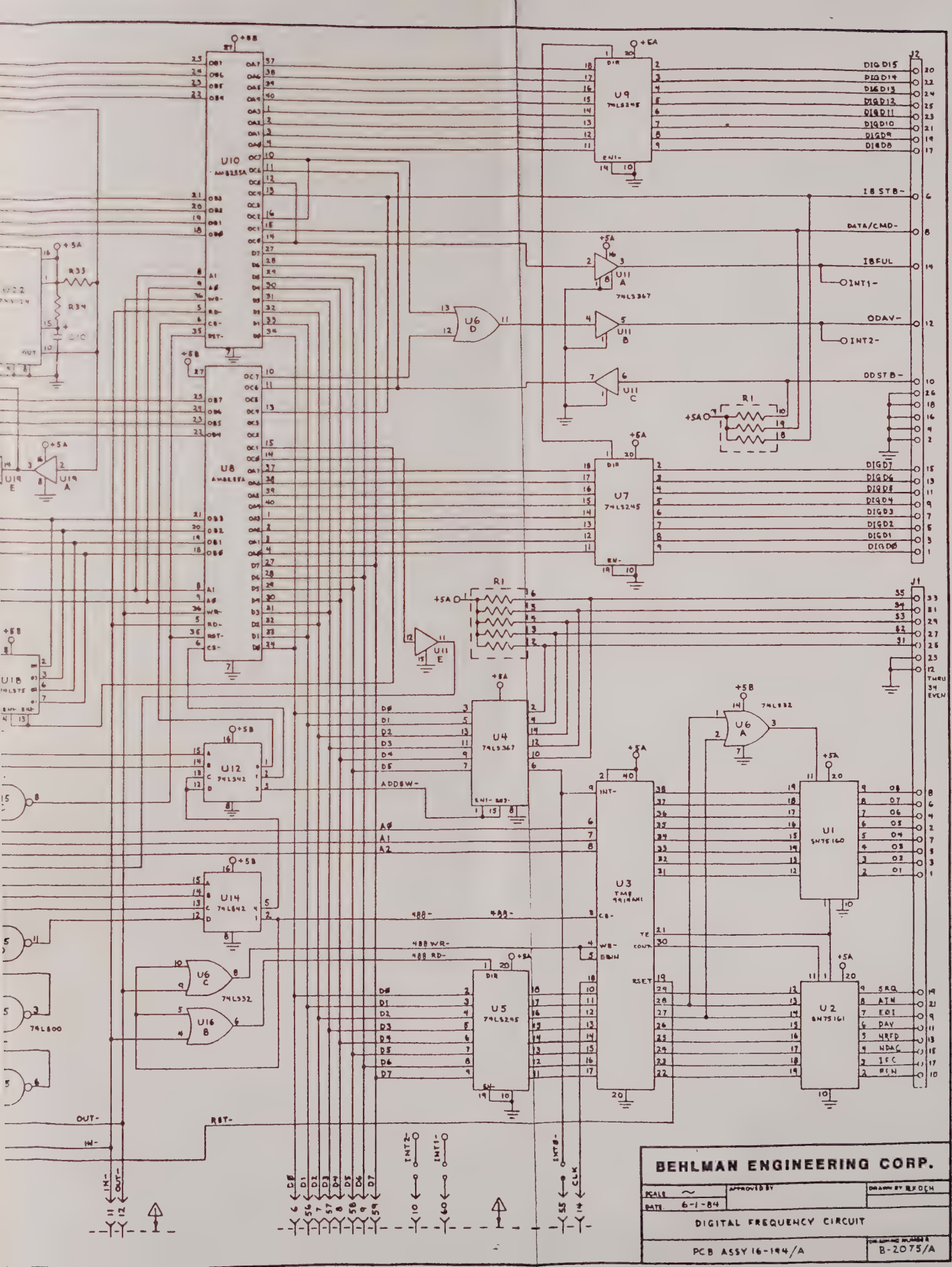
Model KBT-

Assembly/part no. 16-194/A

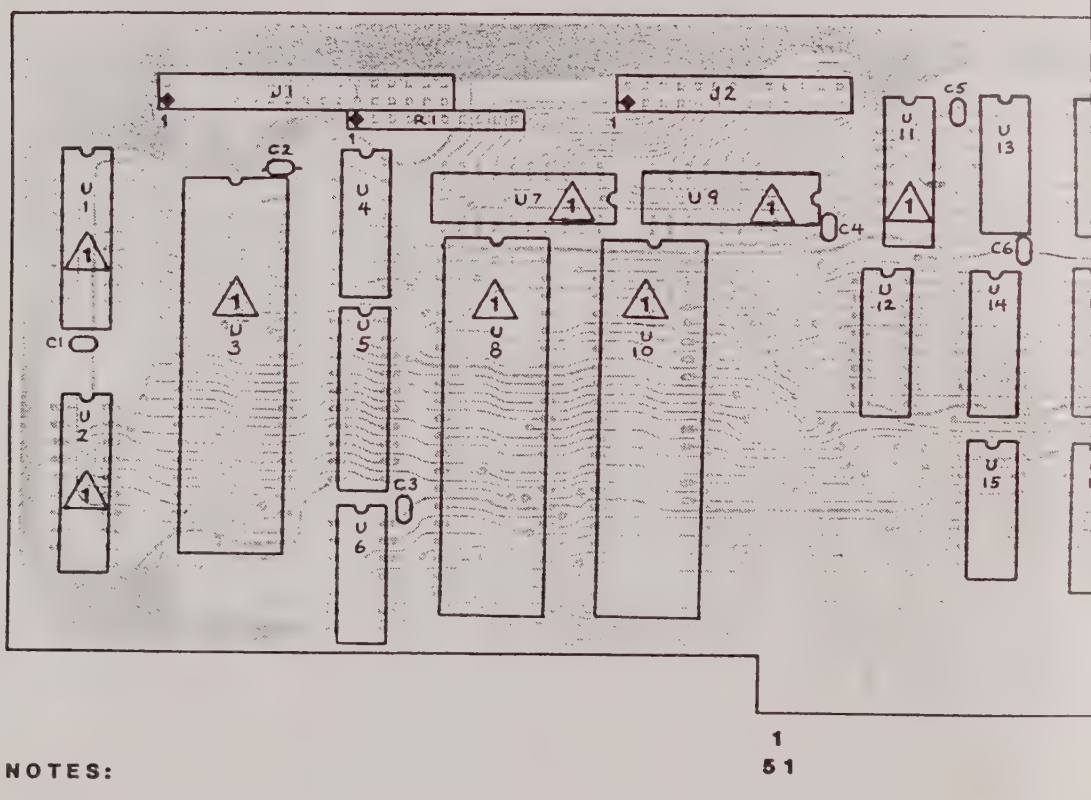
Drawing/ref no. B-2075/A, B-2076/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
U26	Analog Switch, SPDT	MP7512DIJ	Micro Power
U28,30	Quad Operational Amplifer	TL 084CN	TI
U29	Phase-Locked Loop	CD4046BE	RCA
U31	Voltage to frequency converter	9400	Teledyne Semi
VR1	Voltage Regulator 100mA, +5V	MC78L05CT	Motorola
VR2	Voltage Regulator 100mA, -5V	MC79L05CT	Motorola
VR3,6	Voltage Regulator 1.5A, +5V	MC7805CT	Motorola
VR4	Voltage Regulator 1.5A, +15V	MC7815CT	Motorola
VR5	Voltage Regulator 1.5A, -15V	MC7915CT	Motorola
Y1	Crystal 18,000MHz, Fundamental	18.000 NMP-180	JK
Z1	Diode, Zener 5.1V, 1W	IN4733A	Motorola
2 pc	Heat Sink, TO-220	6070B	Thermalloy
1 pc	Printed circuit board	FAB 15-089/A	Behlman
3 pc	IC Socket 40 Pin	40STSD	Cinch
4 pc	IC Socket 20 Pin	20S TSD	CA
1 pc	IC Socket 16 Pin	16S TSD	CA


+8 NOM.
DG
VR2 MC7805
VR6 MC7805
+5A
+5B
+20 NOM.
AG
-20 NOM.
VR4 MC7815
VR5 MC7915
+15
-15
U24 74167
U23 74167
U21 74167
U17 74167
U20 74167
U16 A
U16 B
U16 C
U16 D
74LS32
U13 74LS90
74LS367
Y1 18.000 MHz
C35
C34
U28 A
U28 B
U28 C
U28 D
TL084CN
U25 A
U25 B
CD4066AE
U26 A
U26 B
MP7512DIJ
U19 F
74LS367
U27 CD4050AE
U29 CD4046BE
U31 4400
VR1
VR2
MC79L05
D1
D2
D3
D4
D5
D6
D7
D8
Z1
LO/RE
CLK1
RST-
A1
A2
A3
A4
A5
A6
A7
A8
PCB ASSY 16-190 (1B) OR
16-199 (3B) MOTHERBOARD



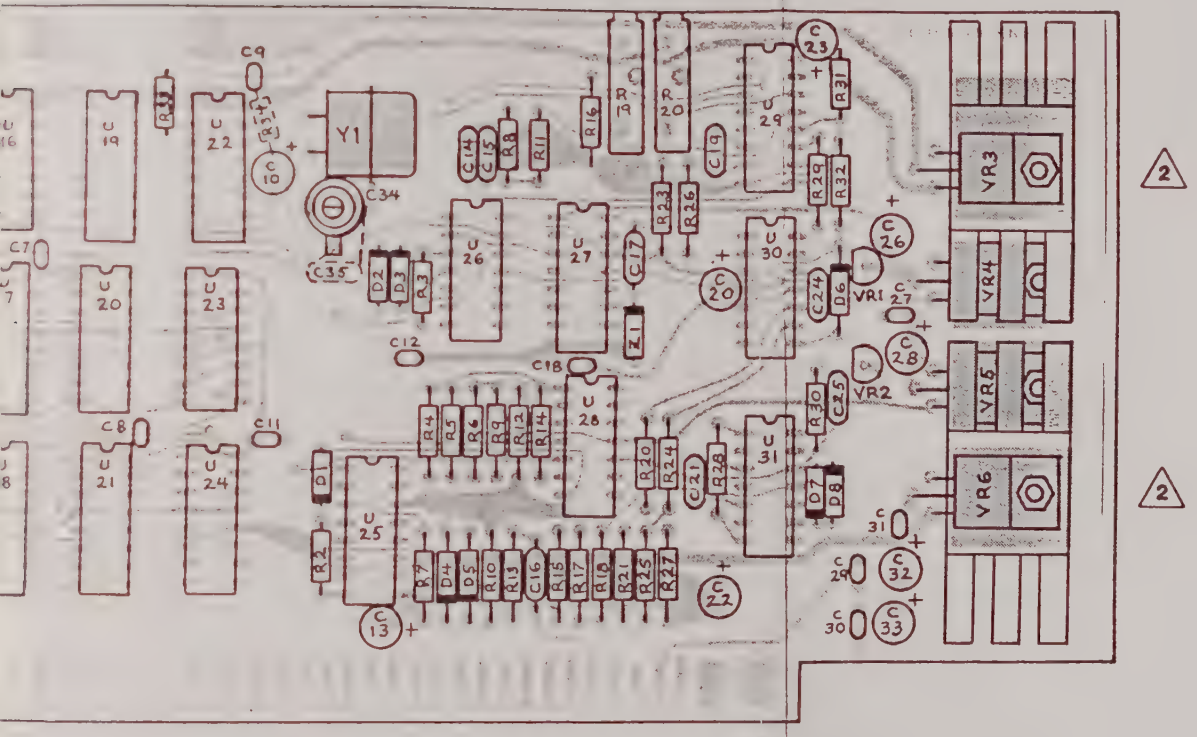
BEHLMAN ENGINEERING CORP.		
SCALE ~	APPROVED BY	DRAWN BY BLF DCH
DATE 6-1-84		
DIGITAL FREQUENCY CIRCUIT		
PCB ASSY 16-194/A		B-2075/A



NOTES:

1. SOCKETS REQUIRED.

2. INSTALL 6070B HEAT SINK WITH THERMALCOTE #251 THERMAL JOINT COMPOUND OR EQUIVALENT.



16-149 OR 16-190	
NEXT ASSY	USED ON
APPLICATION	

Behlman Engineering Corp
SANTA BARBARA, CALIFORNIA

DRAWN BY P.L.KOCH		APPROVED BY
DATE 6-1-84		SCHEMATIC:B-2075/A
TITLE DIGITAL FREQUENCY CARD		
ASSY NO. 16-194/A	DRAWING NO. B-2076	REV A

PARTS LIST

Description MEASUREMENT CARD SINGLE PHASE
Assembly/part no. 16-189/A
Drawing/ref no. B-1868/A, B-2050/A

Model KBT-

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1,2	Capacitor, Dipped mica 24pF, 500V	CM05ED240J03	CDE
C3,6,8,13 15,16,18,	Capacitor, Monolythic 2.2uF, 50V	3C37Z5U225M05B	Sprague
C4,9-12 19-30	Not used		
C5,7	Capacitor, Dipped mica 300pF, 500V	CM05FD301J03	CDE
C14,17 35-40	Capacitor, Tantalum 10uF, 25V	199D106X0025CAT	Sprague
C31	Capacitor, Dipped mica 270pF, 500V	CM05FD271J03	CDE
C32,34, 41-67	Capacitor, Monolythic 0.1uF, 50V	SR205E104MAA	AVX
C33	Capacitor, Dipped mica 68pF, 500V	CM05FD680J03	CDE
C68	Capacitor Monolythic 1uF, 50V	2C7Z5U105M050B	Spregue
D1-7 17,18	Diode 20mA, 100V	1N914A	TI
D8-16	Not used		
R1	Resistor, Carbon Comp 10M ohm, 1/4W 1%	RC07GF106J	Allen-Bradley
R2,7,12, 54-59	Resistor, Metal film 10K, 1/4W, 1%	RN55D 1002F	
R3,4,16,17 22-25,34,35 40,41,86,87	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R5	Resistor, Metal film 2.21K, 1/4W, 1%	RN55D 2211F	

PARTS LIST

Description MEASUREMENT CARD
SINGLE PHASE
Assembly/part no. 16-189/A
Drawing/ref no. B-1868/A, B-2050/A

Model KBT-

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R6,11,15, 46-49,81 97	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
R8	Resistor, Metal film 33.2K, 1/4W, 1%	RN55D 3322F	
R9	Resistor, Metal film 1.82K, 1/4W, 1%	RN55D 1821F	
R10,18-21,26-33,36-45 50-53,74-77,82-85,88,94,100		Not used	
R13	Resistor, Metal film 121K, 1/4W, 1%	RN55D 1213F	
R14	Resistor, Metal film 3.01K, 1/4W, 1%	RN55D 3011F	
R72,73,78 79,95	Potentiometer 25K, 20 turn	89PR25K	Beckman
*R80	Resistor, Metal film 30.1K, 1/4W, 1%	RN55D 3012F	
R89,92	Resistor, Metal film 200 ohm, 1/4W, 1%	RN55D 2000F	
R90	Resistor, Metal film 536K, 1/4W, 1%	RN55D 5363F	
R91	Resistor, Metal film 100 ohm, 1/4W, 1%	RN55D 1000F	
R93	Resistor, Metal film 402K, 1/4W, 1%	RN55D 4023F	
R96,98	Resistor, Metal film 100K, 1/4W, 1%	RN55D 1003F	
R99	Resistor network 5.6K SIP	43/0R-101-562	Bourns
TP1	Test point 1 contact	65593-101	Berg

PARTS LIST

Description MEASUREMENT CARD
SINGLE PHASE

Model KBT-

Assembly/part no. 16-189/A

Drawing/ref no. B-1868/A, B-2050/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
TS1	Test strip 7 contact	65593-108	Berg
U1	Oscillator, Controller	1CM7207A	Intersil
U2,24,25	Not used		
U3	Quad NOR gate 2 input	74LS02	Motorola
U4	Quad D-type latch	74LS75	Motorola
U5-8	Binary Up/down counter	74LS193	Motorola
U9,22	Quad NAND gate 2 input	74LS00	Motorola
U10,11	BCD decoder	74LS42	Motorola
U12,13	Octal D-type latch	74LS373	Motorola
U14,15	NAND gate 8 input	74LS30	Motorola
U16	Operational amplifer	CA3140T	RCA
U17,20	Phase-locked loop	CD4046BE	RCA
U18,21	Up/Down counter Dual synch.	CD4518BE	RCA
U19	Hex inverter buffer	CD4049AE	RCA
U23,26	Quad operational amplifier	TL084CN	TI
U27,28	Quad bilateral switch	CD4066AE	RCA
U29	Analog to digital converter	ADC-ET12BC	Datel
U30	D type Flip-Flop Octal, Tri-state	74LS374	Motorola
U31	Hex Tri-state buffer	74LS367	Motorola
U32	Octal Line driver	74LS244	Motorola

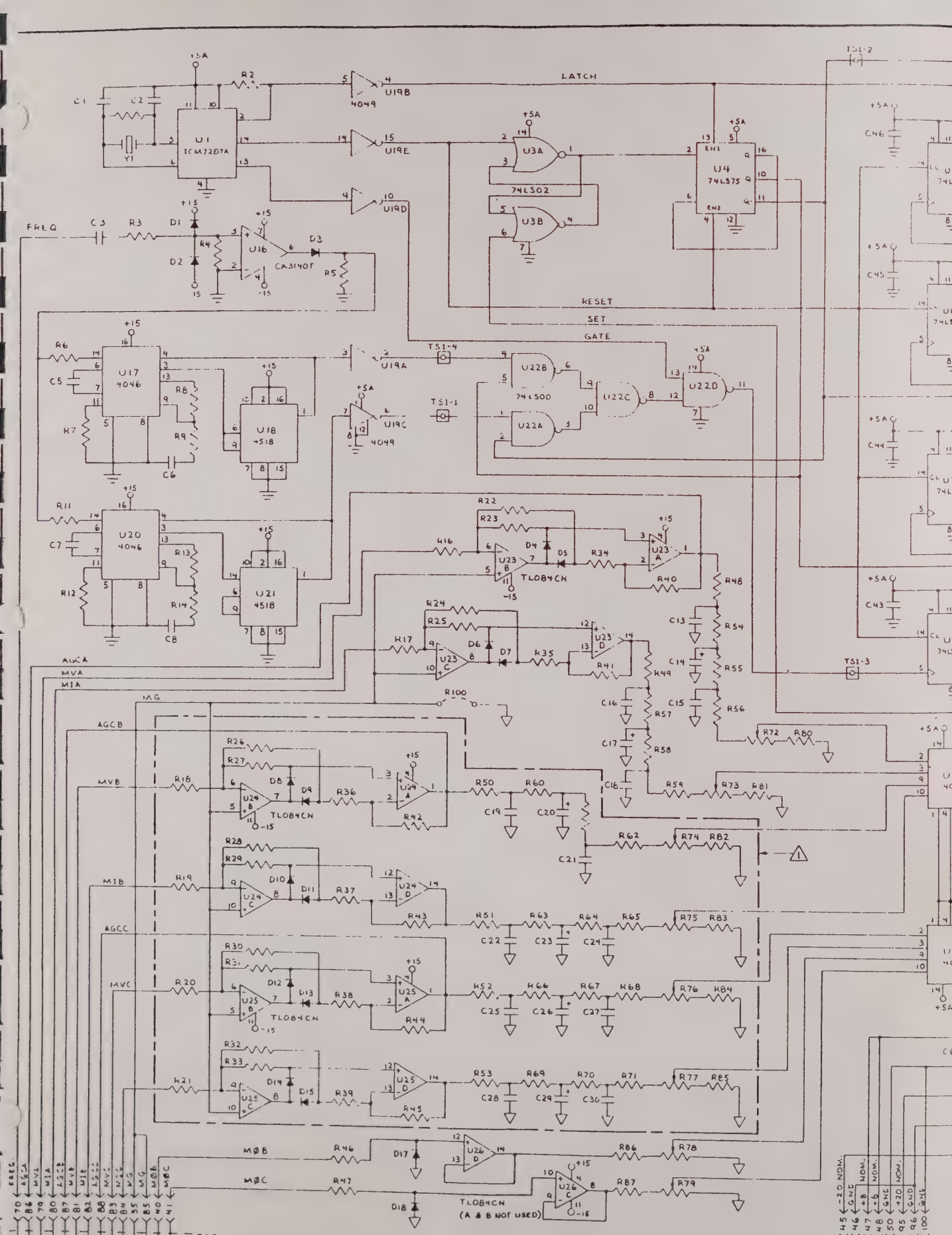
PARTS LIST

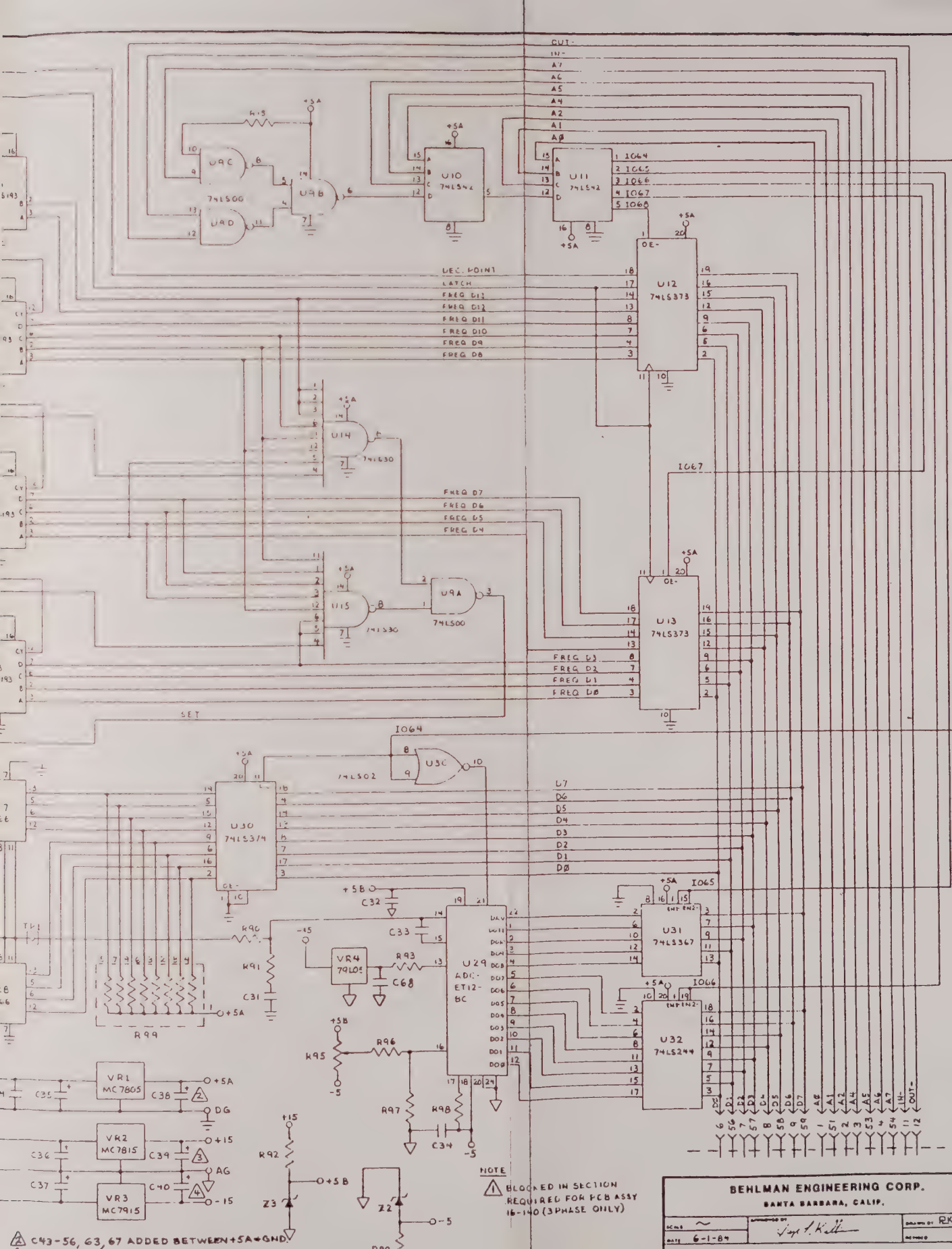
Description MEASUREMENT CARD SINGLE PHASE
Assembly/part no. 16-189/A
Drawing/ref no. B-1868/A, B-2050/A

Model KBT-

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
VR1	Voltage regulator +5V, 1.5A	MC7805CT	Motorola
VR2	Voltage regulator +15V, 1.5A	MC7815CT	Motorola
VR3	Voltage regulator -15V, 1.5A	MC7915CT	Motorola
VR4	Voltage regulator -5V, 100mA	MC79L05CT	Motorola
Y1	Crystal 5.24288 MHz	5.24288	Nymph
Z1	Not used		
Z2,3	Zener diode 5.1V, 1W	1N4733A	Motorola
1pc	IC Socket 14 contact	14S-TSD	CA
1pc	IC Socket 24 contact	24S-TSD	CA
1pc	Heat sink	6070B	Thermalloy
1pc	Printed circuit board	15-072/A	Behlman Eng

* Nominal value, may vary with application.


LATCH
RESET
SET
GATE
FREQ
74LS02
74LS00
TLO84CN
(A & B NOT USED)
AGCA
MVA
MIA
AGCB
MVB
MIB
AGCC
MVC
MØB
MØC
TS1-1
TS1-2
TS1-3
TS1-4


U9C
U9D
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U9B
+5A
R95
U10
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U11
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1 I064
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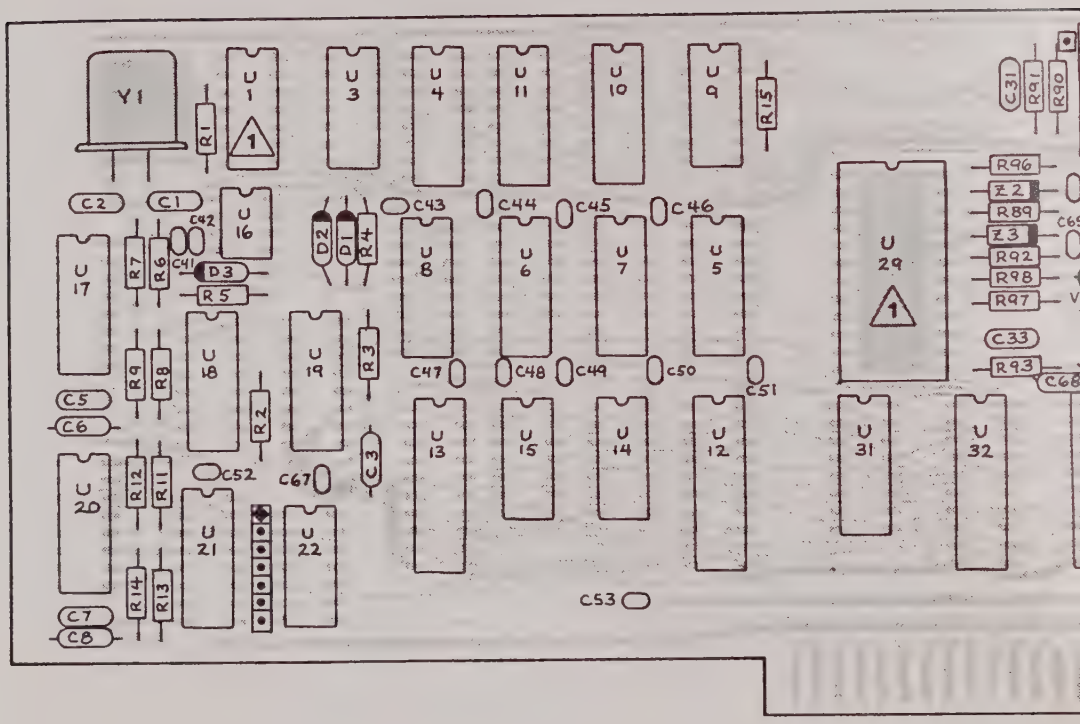
3 I066
4 I067
5 I068
OUT-
IN-
A7
A6
A5
A4
A3
A2
A1
A0
SEC. POINT
LATCH
FREQ D13
FREQ D12
FREQ D11
FREQ D10
FREQ D9
FREQ D8
U12
74LS373
OE-
U14
74LS30
FREQ D7
FREQ D6
FREQ D5
FREQ D4
U15
74LS30
U9A
74LS00
FREQ D3
FREQ D2
FREQ D1
FREQ D0
U13
74LS373
SET
I064
74LS02
U3C
U30
74LS374
D7
D6
D5
D4
D3
D2
D1
D0
+5B
C32
C33
R90
R91
C31
R99
VR4
79L05
R93
C68
U29
ADC-ET12-BC
R96
R97
R98
C34
R92
Z3
Z2
I065
U31
74LS367
I066
U32
74LS244
VR1
MC7805
VR2
MC7815
VR3
MC7915
C35
C38
C36
C39
C37
C40
+15
AG
-15
NOTE
BLOCKED IN SECTION REQUIRED FOR PCB ASSY 16-140 (3 PHASE ONLY)
C43-56, 63, 67 ADDED BETWEEN +5A + GND
BEHLMAN ENGINEERING CORP.
SANTA BARBARA, CALIF.
6-1-84
RK



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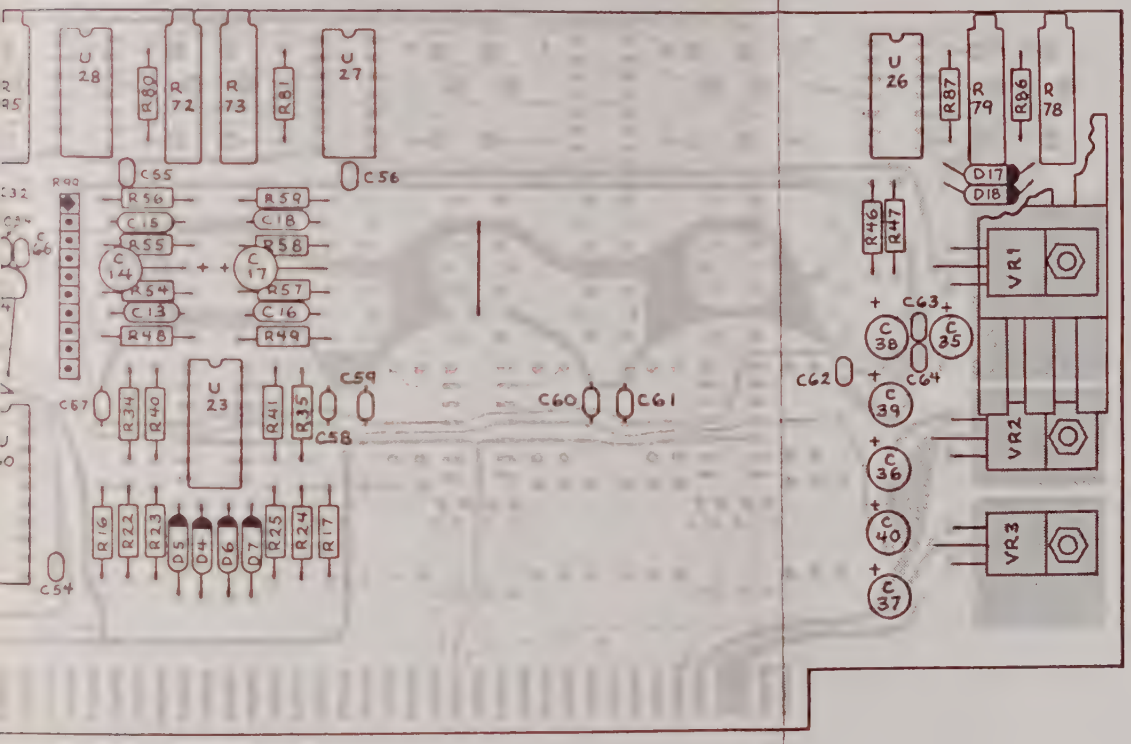
NOTES:

1. SOCKETS REQUIRED.

2. INSTALL 6070B HEAT SINK WITH THERMALCOTE #251 THERMAL JOINT COMPOUND OR EQUIVALENT.



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16-190	
NEXT ASSY	USED ON
APPLICATION	

Behlman Engineering Corp
SANTA BARBARA, CALIFORNIA

DRAWN BY P.L.KOCH	APPROVED BY	
DATE 6-1-84	SCHEMATIC: B-1868/A	
TITLE SINGLE PHASE MEASUREMENT CARD		
ASSY NO. 16-189/A	DRAWING NO. B-2050	REV A

PARTS LIST

Description VOLTAGE CARD
SINGLE PHASE
Assembly/part no. 16-179
Drawing/ref no. B-1859, B-1860

Model KBT

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1-8	Capacitor, Tantalum 10uF, 25V	99D106X0025C31	Sprague
C9,10,31,34	Capacitor, Monolythic 1.0uF, 50V	5CZU105X0050C5	Sprague
C11-14,17-20,22,23,28,29,33-37 42-45,49,50,54,55,58,59,62,63		Not used	
C15,16,24-26 38-41,46-48, 51-53,56,57 60,61	Capacitor, Monolythic 0.1uF, 50V	SR205E104MAA	AVX
C21,27 30,32	Capacitor, Monolythic 2.2uF, 50V	3C37Z5U225M05B	Sprague
C64,65	Capacitor, Dipped mica 56pF	CM05ED560J03	CDE
C66	Capacitor, Mica 100pF, 1500V	CM05ED101J03	CDE
R1,3,4,6,7,9,10,12,13,15,16,18 19,21,22,24,25,27,28,30,31,33 34,36,37,39,40,42,43,45,46		Not used	
R2	Resistor, Metal film 5.11K, 1/4W, 1%	RN55D 5111F	
R5,23 29,52	Potentiometer 25K, 20 turn	89PR25K	Beckman
R11	Resistor, Metal film 392 ohm, 1/4W, 1%	RN55D 3920F	Mepco
*R14	Resistor, Metal film 110K, 1/4W, 1%	RN55D 1103F	
R17,20	Resistor, Metal film 4.99K, 1/4W, 1%	RN55D 4991F	
R8,50	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	Mepco
R26	Resistor, Metal film 9.53K, 1/4W, 1%	RN55D 9531F	

PARTS LIST

Description VOLTAGE CARD
SINGLE PHASE

Model KBT

Assembly/part no. 16-179

Page 2 of 4

Drawing/ref no. B-1859, B-1860

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
R32	Resistor, Metal film 8.25K, 1/4W, 1%	RN55D 8251F	Mepco
R35,41	Resistor, Metal film 30.1K, 1/4W, 1%	RN55D 3012F	
R38,48	Resistor, Metal film 10K, 1/4W, 1%	RN55D 1002F	
R44	Resistor, Metal film 12.1K, 1/4W, 1%	RN55D 1212F	
R47	Resistor, Metal film 200 ohm, 1/4W, 1%	RN55D 2000F	
R49	Resistor, Metal film 261 ohm, 1/4W, 1%	RN55D 2610F	
R51	Resistor, Metal film 2.55K, 1/4W, 1%	RN55D 2551F	
R55	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
TS1	Test strip 6 contact	65593-106	Berg
TS2,3,5,6	Not used		
TS4	Test strip 12 contact	65593-112	Berg
U1-4,9-14,16,17,19,20,22,23,25 26,28,29,31-33,35,36,38,39,42,43		Not used	
U5	Monostable multivibrator	74121	Motorola
U6-8	Binary Up/Down counter	74LS193	Motorola
U15	EPROM, memory	D2732A	Intel
U18,37	Octal D-type Flip-Flop, Tri-state	74LS374	Motorola

PARTS LIST

Description VOLTAGE CARD
SINGLE PHASE
Assembly/part no. 16-179
Drawing/ref no. B-1859, B-1860

Model KBT

Page 3 of 4

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
U21	Digital to Analog converter, 8 Bit	HI5618A-5	Harris
U24,33	Quad operational amplifier	TL084CN	TI
U27	Analog switch Dual, SPDT	MP7512DIJ	Micro Power
U30	Analog multiplier	4214AP	Burr-Brown
U34	Quad D-type Filp-Flop	74LS175	Motorola
U40	Octal line driver	SN74LS244	Motorola
U41	DAC, multiplying 12 Bit	AD7521LN	Intersil
U44	Quad NAND gate 2 Input	74LS132	Motorola
U45	BCD decoder	74LS42	Motorola
U46	4 to 16 Line decoder	74LS154	Signetics
VR1,2	Voltage regulator +5V, 1.5A	MC7805CT	Signetics
VR3	Voltage regulator +15V, 1.5A	MC7815CT	Signetics
VR4	Voltage regulator -15V, 1.5A	MC7915CT	Signetics
Z1	Zener diode 5.1V, 1W	1N4733CT	Signetics
Z2	Zener diode 12V, 1W	1N4742A	Motorola
1pc	IC Socket 14 contact	14S-TSD	CA
2pcs	IC Socket 18 contact	18S-TSD	CA

PARTS LIST

Description VOLTAGE CARD
SINGLE PHASE

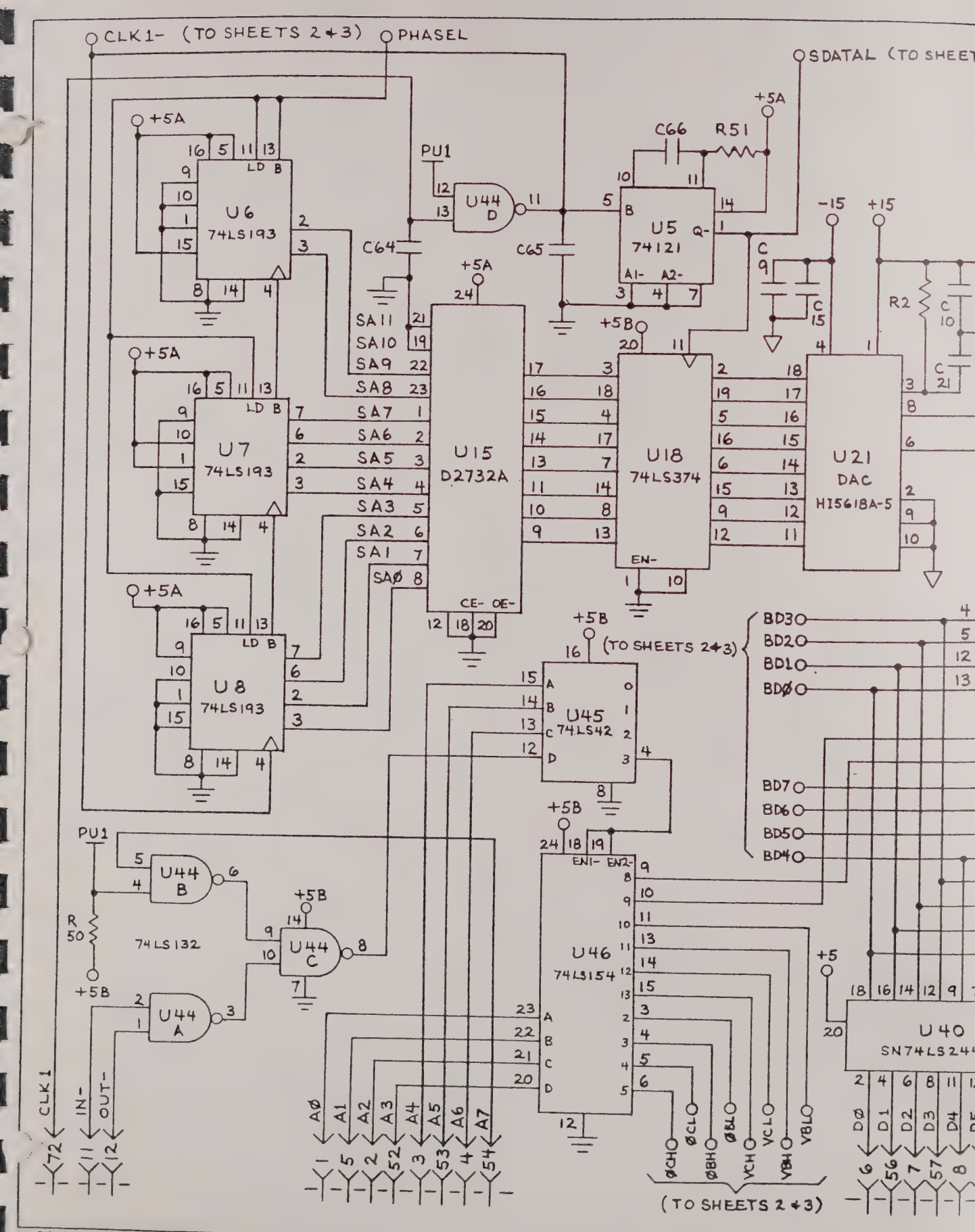
Assembly/part no. 16-179

Drawing/ref no. B-1859, B-1860

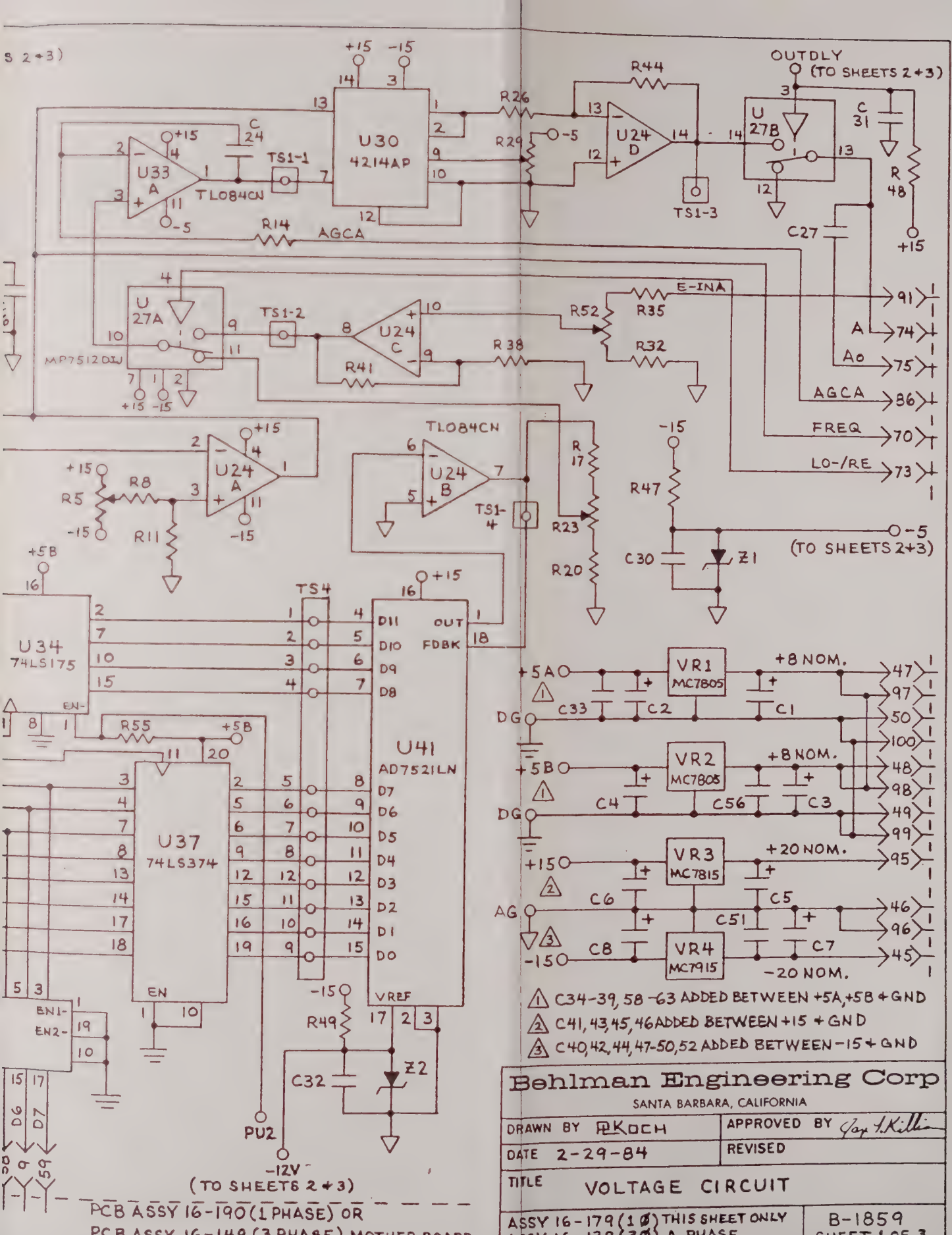
Model KBT

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
1pc	IC Socket 24 contact	24S-TSD	CA
2pcs	Heat sink	6070B	Thermalloy
BB1-3	Buss bar	B10200-900-12-100C	Bussco
1pc	Printed circuit board	15-070/A	Behlman Eng.

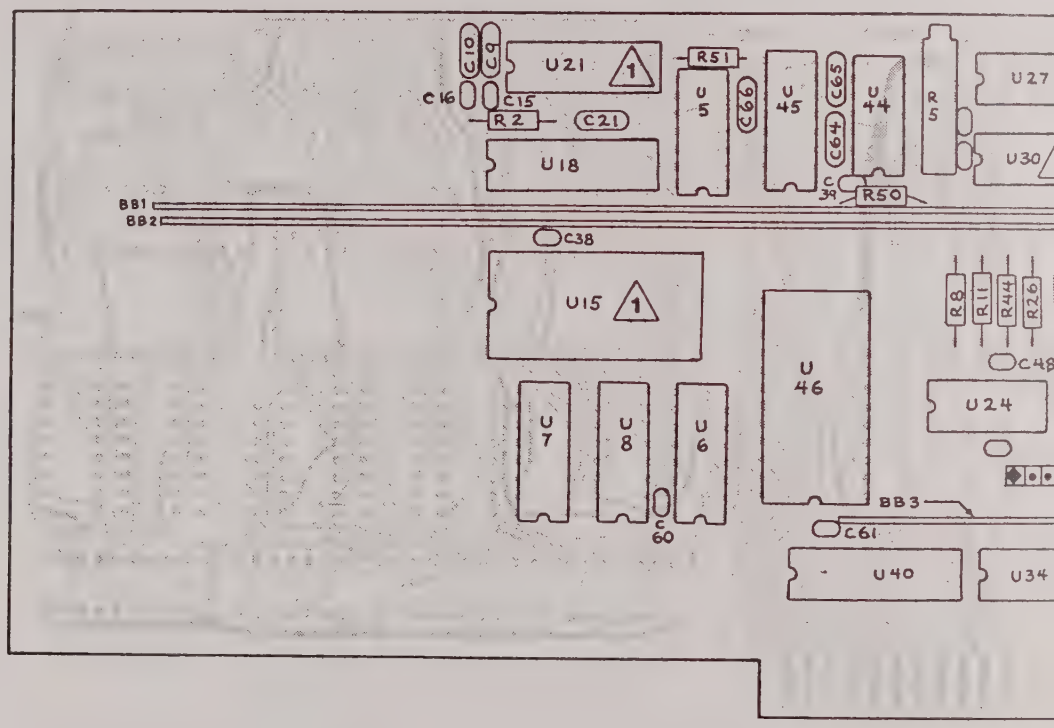
* Nominal value, may vary with application.



BISHOP GRAPHICS/ACCUPRESS
REORDER NO A11215



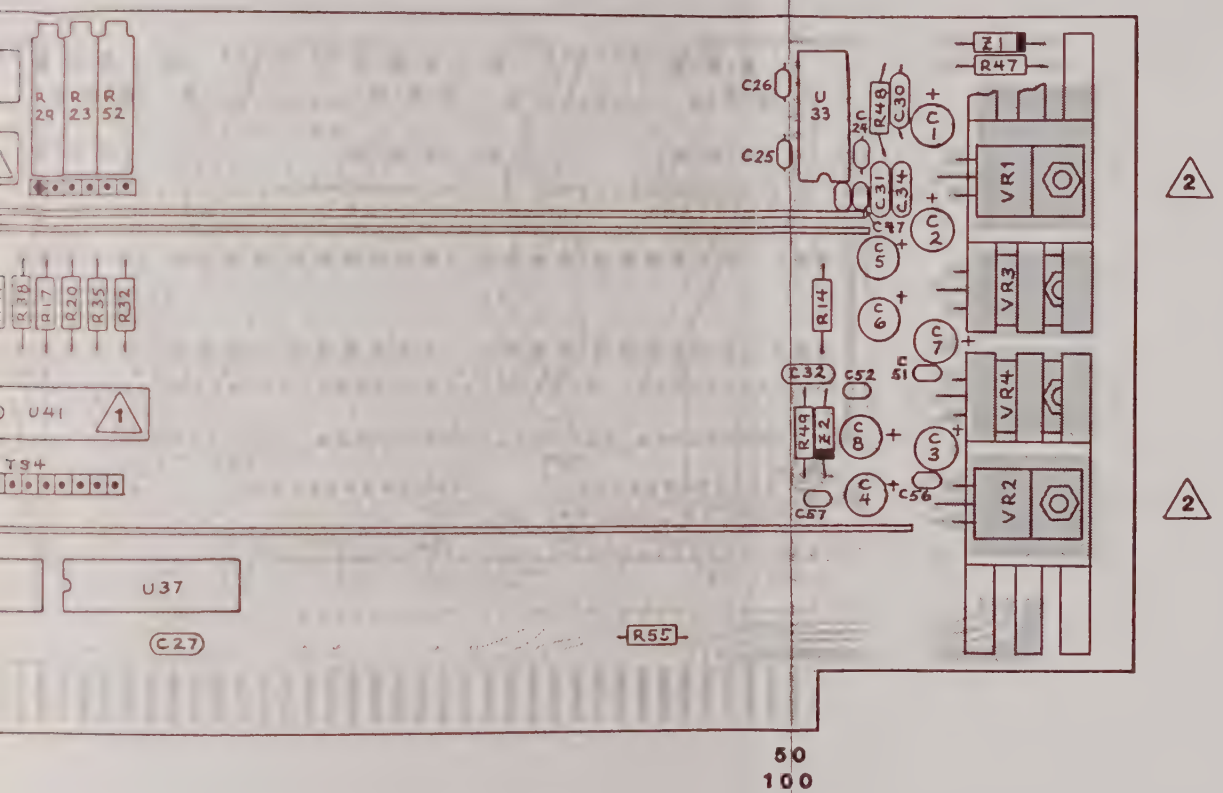
Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY R KOCH	APPROVED BY Jay L. Killin
DATE 2-29-84	REVISED
TITLE VOLTAGE CIRCUIT	
ASSY 16-179 (1 Ø) THIS SHEET ONLY ASSY 16-138 (3 Ø) A PHASE	B-1859 SHEET 1 OF 3



NOTES:

1. SOCKETS REQUIRED.

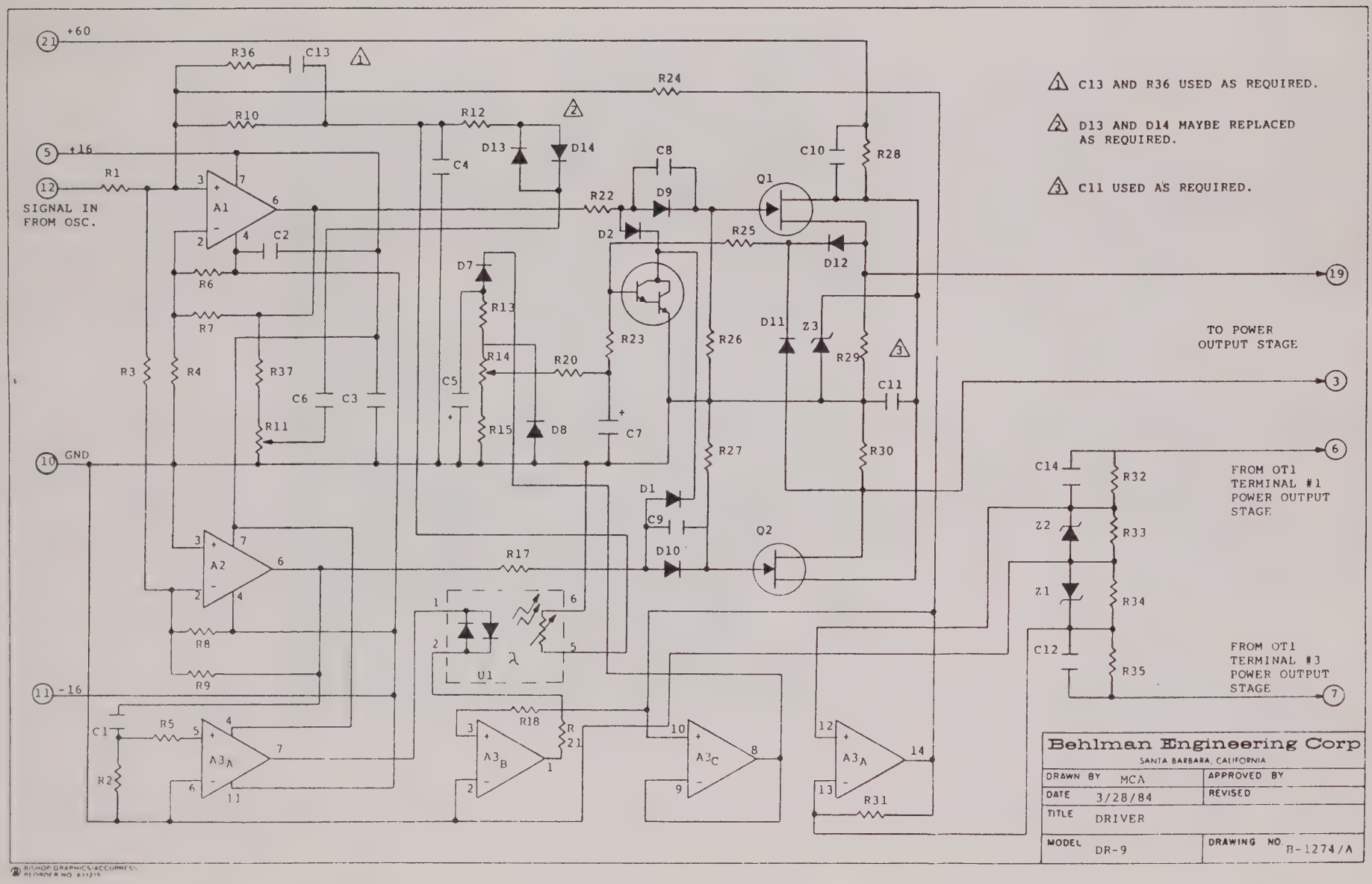
2. INSTALL 6070B HEAT SINK WITH THERMALCOTE #251 THERMAL JOINT COMPOUND OR EQUIVALENT.



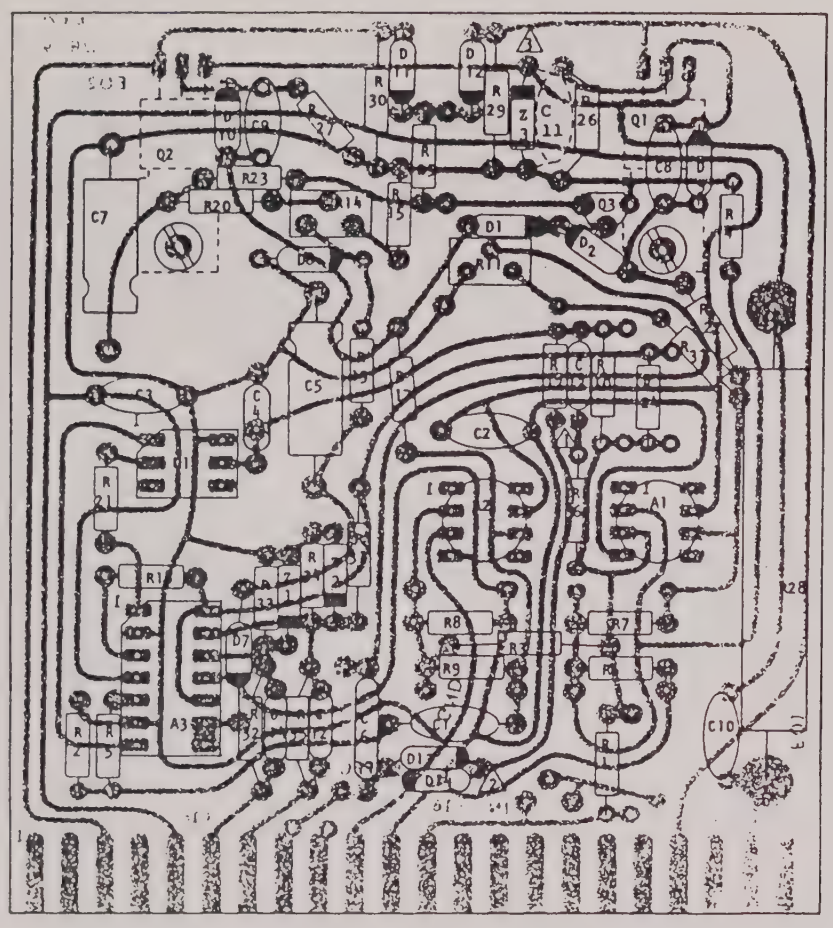
16-190	
NEXT ASSY	USED ON
APPLICATION	

Behlman Engineering Corp
SANTA BARBARA, CALIFORNIA

DRAWN BY P.L.KOCH	APPROVED BY	
DATE 6-1-84	SCHEMATIC: B-1859	
TITLE SINGLE PHASE VOLTAGE CARD		
ASSY NO. 16-179	DRAWING NO. B-2037	REV



BISHOP GRAPHICS-ACCUPRESS
REORDER NO 41215



NOTE:

1. C13 AND R36 USED AS REQUIRED.
2. D13 AND D14 MAY BE REPLACED WITH JUMPER AS REQUIRED.
3. C11 USED AS REQUIRED. INSTALLED ON CIRCUIT SIDE.

Behlman Engineering Cor SANTA BARBARA, CALIFORNIA	
DRAWN BY PLK	APPROVED BY
DATE 10/31/83	SCHEMATIC: B-1274
TITLE COMPONENT LAYOUT	
MODEL DR-9	DRAWING NO. B-1219/A

BISHOP GRAPHICS/ACCUPRINT
REORDER NO A11215

PARTS LIST

Description DRIVER

Model

Assembly/part no. DR-9

Drawing/ref no. B-1274/A, B-1219/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
A1,2	Operational Amplifier	CA3140T	RCA
A3	Quad Operational Amplifier	TL084CN	TI
C1	Capacitor, Disk .15uF, 50V	SR205E154MAA	AVX
C2,3	Capacitor, Disk .1uF, 50V	SR205E104MAA	AVX
C4,8,9	Capacitor, Disk 1000pF, 1000V	DD-102	Centralab
C5,7	Capacitor, Electrolytic 25uF, 25V	TVA-1205	Sprague
C6	Capacitor, Monolythic 1.0uF, 50V	5CZ5U105X0050C5	Sprague
C10	Capacitor, Disk .05uF, 100V	TG-S50	Sprague
C11	Capacitor, Disk .02uF, 100V (use as required)	TG-S20	Sprague
C12,14	Capacitor, Mica 68pF, 500V	CM05ED680J03	CDE
*C13	Capacitor, Mica 2500pF, 500V	CMO6FD252JO3	CDE
D1,2,7-12	Diode, Signal 20mA, 100V	1N914A	Fairchild
D3-6	Not used		
D13,14	Diode, Signal 20mA, 100V (used as required)	1N914A	Fairchild
Q1,2	Field Effect Transistor	VN88AF	Siliconix

PARTS LIST

Description DRIVER

Model

Assembly/part no. DR-9

Drawing/ref no. B-1274/A, B-1219/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
Q3	Transistor, NPN	2N5308	RCA
*R1	Resistor, Metal film 15K, 1/4W, 1%	RN55D 15002F	
R2,5,18	Resistor, Metal film 100K, 1/4W, 1%	RN55D 1003F	
R3	Resistor, Metal film 9.53K, 1/4W, 1%	RN55D 9531F	
R4,26,27	Resistor, Metal film 10K, 1/4W, 1%	RN55D 1002F	
*R6,8	Resistor, Metal film 1.10M, 1/4W, 1%	RN55D 1104F	
R7,9	Resistor, Metal film 205K, 1/4W, 1%	RN55D 2053F	
*R10	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R11,14	Potentiometer, Trimming 5K, Single turn	63X502	Spectrol
R12	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R13	Resistor, Metal film 4.7K, 1/4W, 1%	RN55D 4701F	
R15	Resistor, Metal film 392 Ohm, 1/4W, 1%	RN55D 3920F	
R16,19	Not used		
R17,22,27 *R25	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
R20	Resistor, Metal film 681 Ohm, 1/4W, 1%	RN55D 6810F	

PARTS LIST

Description DRIVER

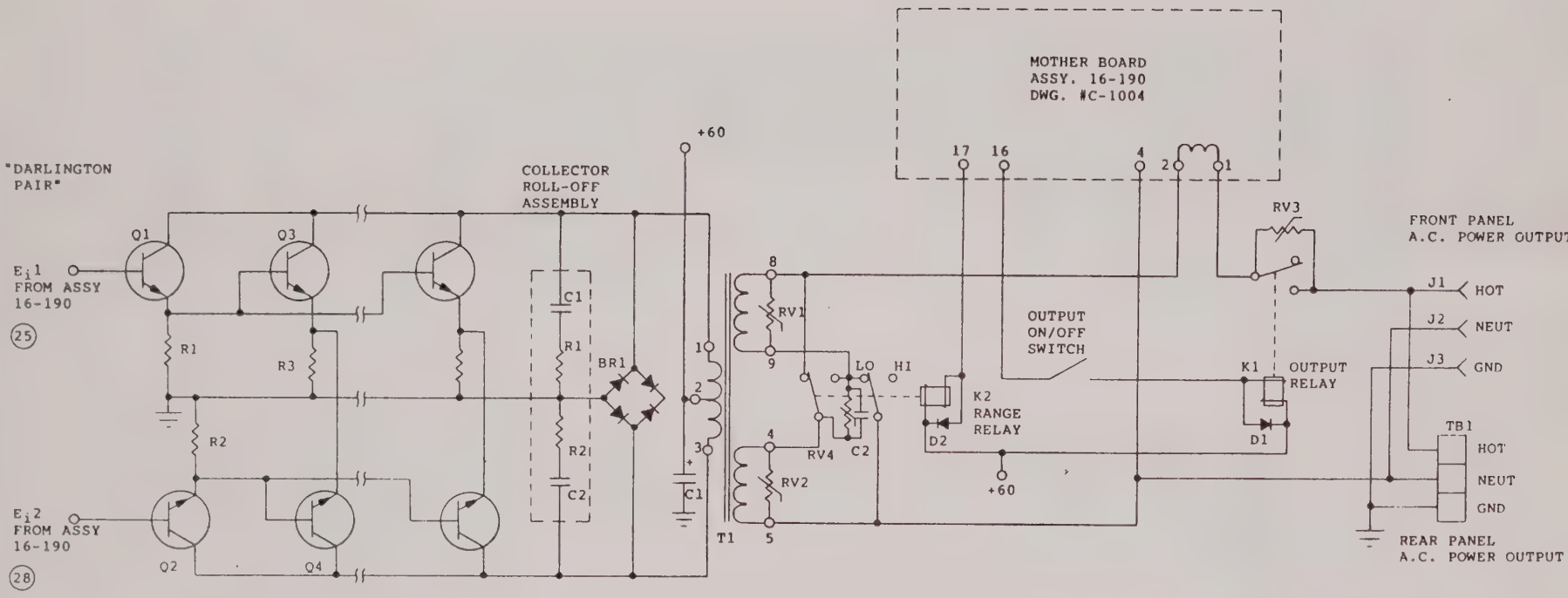
Model

Assembly/part no. DR-9

Drawing/ref no. B-1274/A, B-1219/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
*R21	Resistor, Metal film 78K, 1/4W, 1%	RN55D 7802F	
R23,29,30	Resistor, Metal film 100 Ohm, 1/4W, 1%	RN55D 1000F	
*R24	Resistor, Metal film 12.1K, 1/4W, 1%	RN55D 1212F	
*R33	Resistor, Metal film 1.5K, 1/4W, 1%	RN55D 1501F	
*R28	Resistor, Wirewound 250 Ohm, 10W	RW68 V251	Dale
R31,34	Resistor, Metal film 3.01K, 1/4W, 1%	RN55D 3011F	
*R32,35	Resistor, Metal film 30.1K, 1/4W, 1%	RN55D 3012F	
R36	Resistor, Metal film 30.1K, 1/4W, 1%	RN55D 3012F	
U1	Photodiode	CLM 60	Clairex
Z1,2	Zener diode 14V, 5W	1N5244A	Motorola
Z3	Zener diode 75V, 1W	1N4761A	Motorola
1 pc	Printed circuit board	DR-9	Behlman Eng.
1 pc	P/C edge connector 22 contact	50-22A-20	TRW/Cinch
1 pc	Heat sink	29-001	Behlman Eng.

* Nominal value, actual value may vary with application.



NOTE:

C1 USED AS REQUIRED.

Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY WH	APPROVED BY
DATE 3/14/84	REVISED
TITLE POWER OUTPUT STAGE	
MODEL KBT 100-1000 VA	DRAWING NO B-2097/A

BISHOP GRAPHICS/ACCUPRESS
NEGATIVE NO. 811215

PARTS LIST

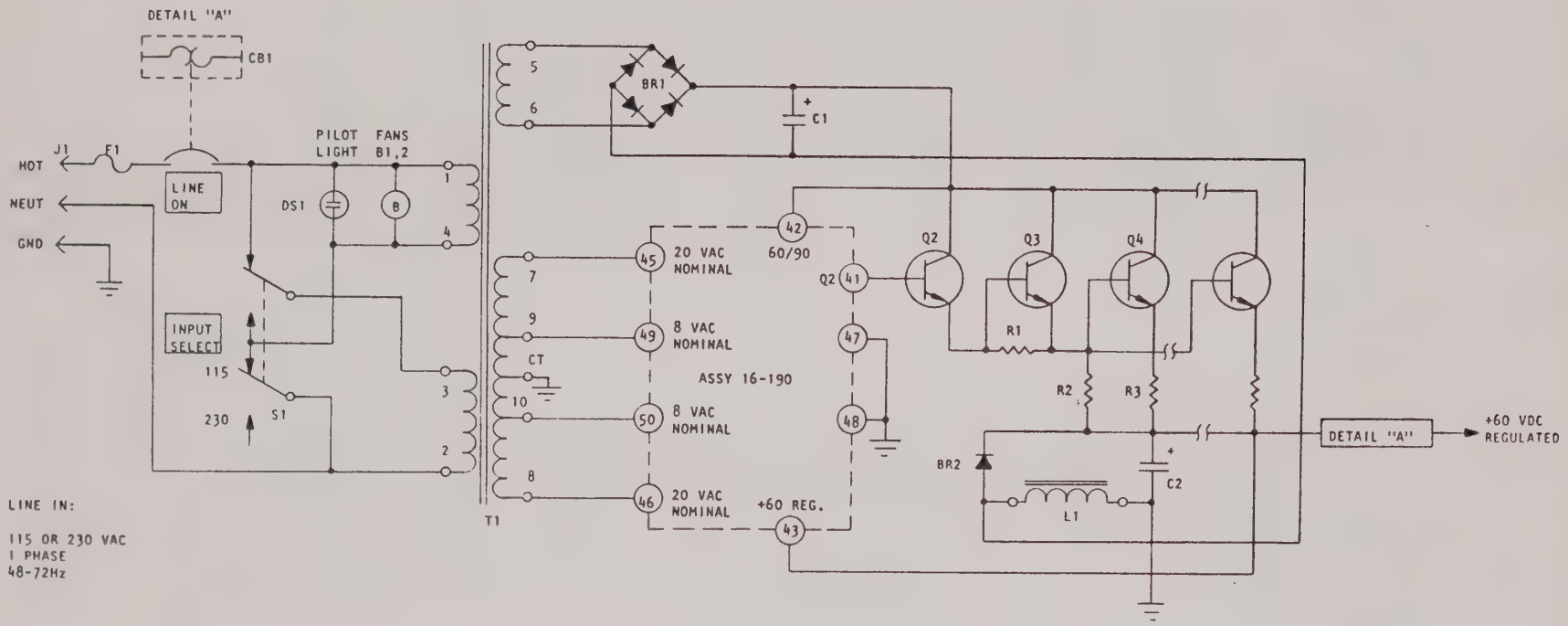
Description POWER OUTPUT STAGE

Model KBT-50-A;C

Assembly/part no.

Drawing/ref no. B-2097/A

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
BR1	Bridge rectifier 25A, 200V	250JB2L	IR
*C1	Capacitor, Electrolytic 200uF, 150V	TVA 1423	Sprague
C2	Capacitor, Dipped mica 4700pF, 500V	CM06FD472J03	CDE
D1,2	Diode 1A, 200V	1N4004	Motorola
J1	Binding post 30A, Red	BP30R	Superior
J2	Binding post 30A, White	BP30WT	Superior
J3	Binding post 30A, Black	BP30B	Superior
K1,2	Relay TPDT, 11A, 24Vdc, coil	W388X-11	Magnecraft
Q1-16	Transistor, Power, NPN	2N6259	RCA
R1-2	Resistor, Wirewound 2 ohm, 3W	RW69V2R0	Dale
R3-9	Resistor, Wirewound 0.5 ohm, 3W	RW69VR50	Dale
RV1,2,4	Varistor	V150LA20B	GE
RV3	Varistor	V275LA40B	GE
S1	Switch, Toggle SPST, 6A	80994 BD	Arrow-Hart
S2	Switch, Rotary 3 pole, 5 position Non-shorting	PA-2007	Centralab



Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY PS	APPROVED BY
DATE 3/12/84	REVISED
TITLE D.C. POWER SUPPLY	
MODEL KBT 350-750 VA	DRAWING NO B-2138

BISHOP GRAPHICS/ACCUPRESS
REORDER NO. A11215

PARTS LIST

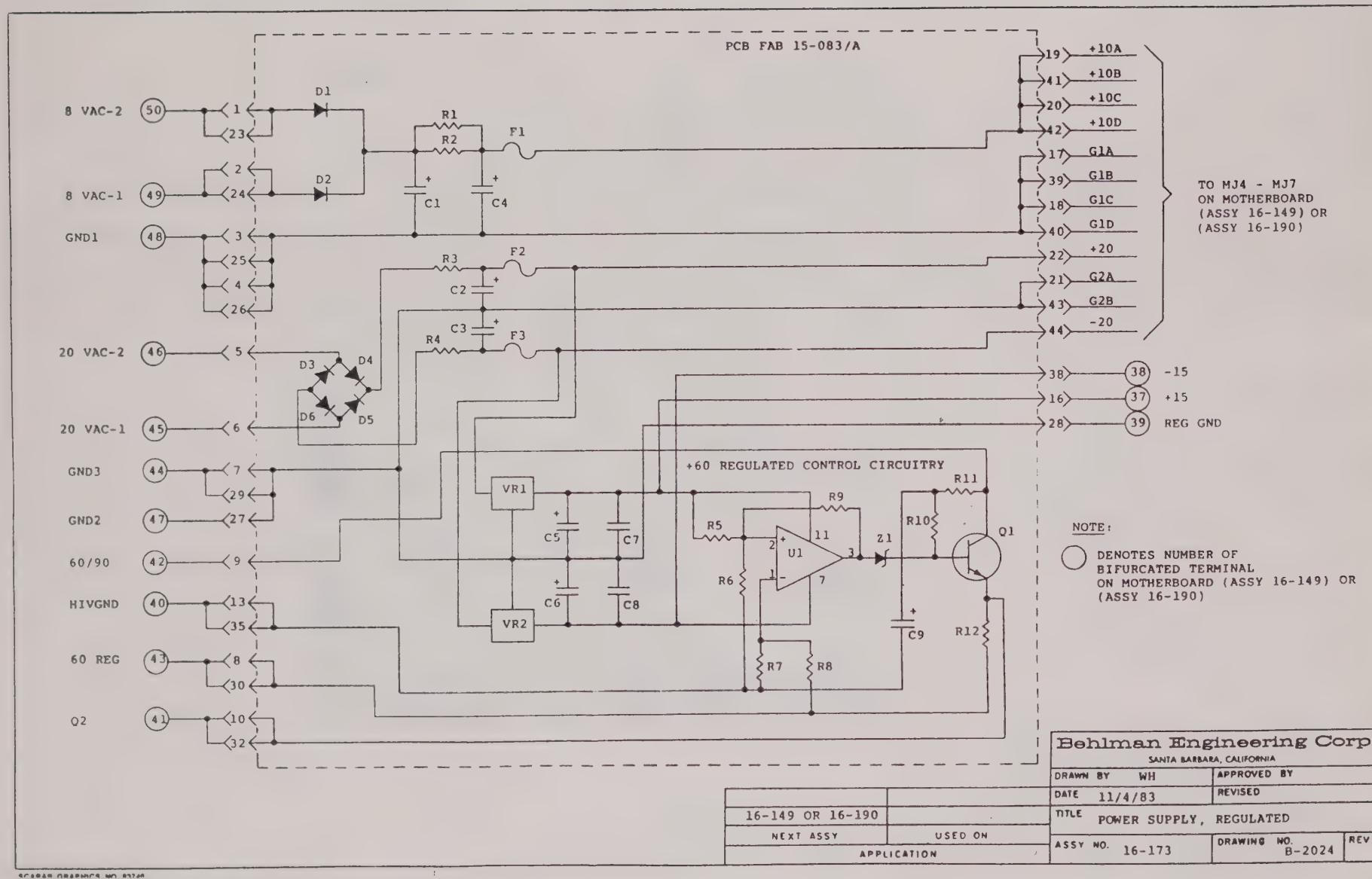
Description DC POWER SUPPLY

Model KBT-50-A;B;C;D

Assembly/part no.

Drawing/ref no. B-2138

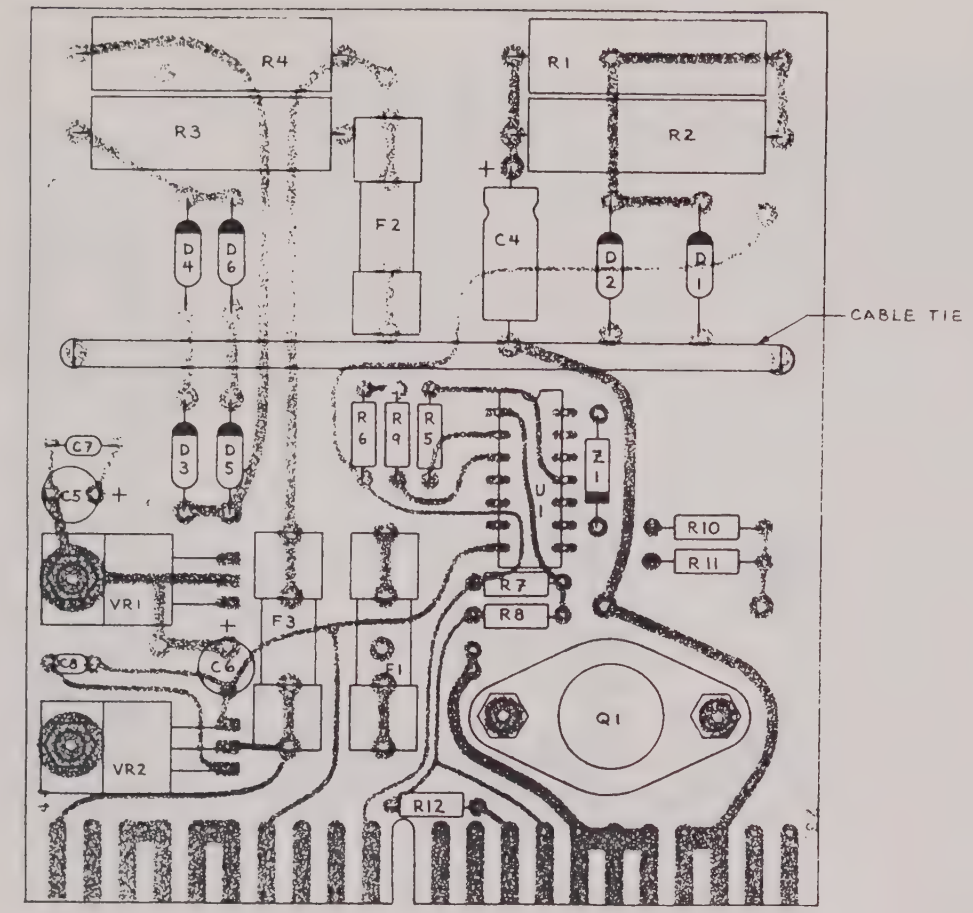
REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
B1-2	Fan 115 Vac, 115 CFM	4600X	Pamotor
BR1	Bridge rectifier 50A, 200V	MPI5020	EDI
BR2	Bridge rectifier 25A, 200V	250JB2L	IR
C1,2	Capacitor, Electrolytic Two 5200uF, 150V, in parallel	CGS522U150W4C	Mallory
CB1	Circuit Breaker	UPG-6-4-60-502	Airpax
DS1	Pilot Light, Neon	507-4538-1431-630	Dialco
J1	Power Cord Connector	17252	Belden
L1	Reactor .6mH, 16A	L-0006-16	Behlman Eng.
Q2-6	Transistor, Power, NPN	2N6259	RCA
R1,2	Resistor, Carbon Comp. 10 ohm, 2W, 5%	RC42GF100J	Allen Bradley
R3-5	Resistor, Wirewound 0.1 ohm, 10W	RE65GR100	Allen Bradley
T1	Transformer, Power Input	PT-8-20-2K	Behlman Eng.
1pc	P/C Assembly Mother Board Dwg. No. C-1004	16-190	Behlman Eng.



16-149 OR 16-190	
NEXT ASSY	USED ON
APPLICATION	

Behlman Engineering Corp
SANTA BARBARA, CALIFORNIA

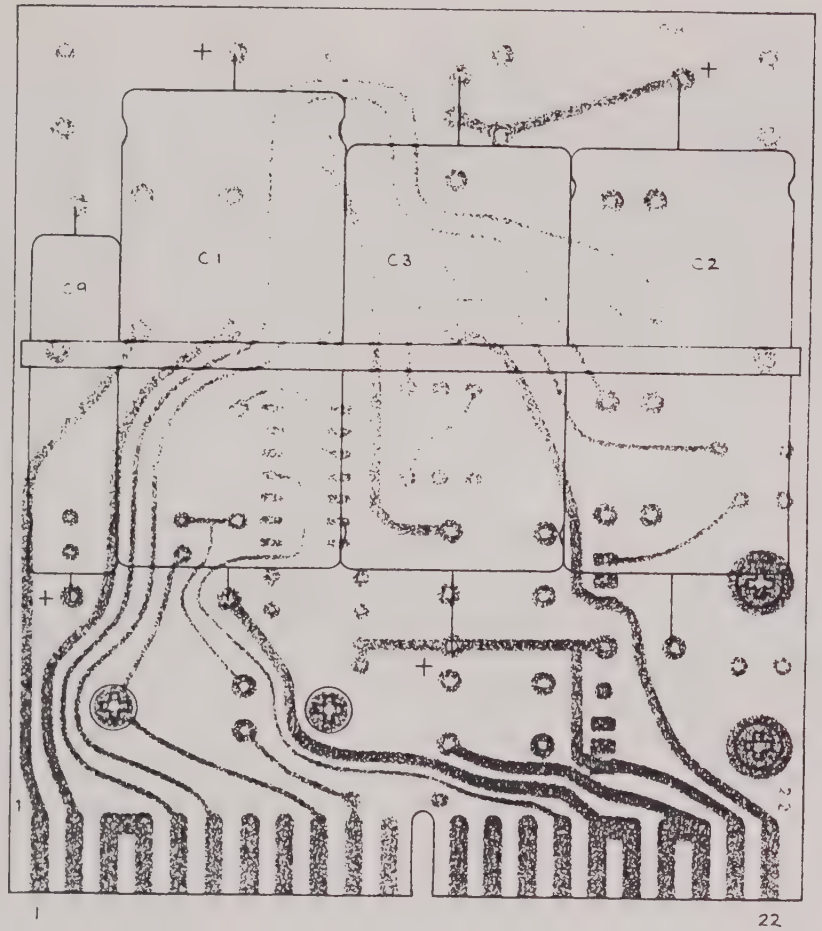
DRAWN BY WH	APPROVED BY
DATE 11/4/83	REVISED
TITLE POWER SUPPLY, REGULATED	
ASSY NO. 16-173	DRAWING NO. B-2024 REV



Behlman Engineering Corp SANTA BARBARA, CALIFORNIA	
DRAWN BY RK	APPROVED BY
DATE 10-26-83	SCHEMATIC: B-2024
TITLE POWER SUPPLY, REGULATED	
ASSY NO. 16-173	DRAWING NO. B-2025 SHEET 1 OF 2 REV

16-149 OR 16-190	
NEXT ASSY	USED ON
APPLICATION	

DCARAB GRAPHICS NO. 83746



16-149 OR 16-190	
NEXT ASSY	USED ON
APPLICATION	

Behlman Engineering Corp
SANTA BARBARA, CALIFORNIA

DRAWN BY RK	APPROVED BY
DATE 10-26-83	SCHEMATIC: B-2024
TITLE POWER SUPPLY, REGULATED	
ASSY NO. 16-173	DRAWING NO. SHEET 8-2025 2 OF 2 — REV

SCARAB GRAPHICS NO. 83748

PARTS LIST

Description DC POWER SUPPLY, REGULATED

Assembly/part no. 16-173

Drawing/ref no. B-2024, B-2025

Model KBT-

Page 1 of 2

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
C1	Capacitor, Electrolytic 5000uF, 16V	TVA-1175.5	Sprague
C2,3	Capacitor, Electrolytic 2000uF, 25V	TVA-1213	Sprague
C4	Capcaitor, Electrolytic 25uF, 25V	TVA-1205	Sprague
C5,6	Capacitor, Tantalum 10uF, 25V	199D106X0025CAT	Sprague
C7,8	Capacitor, Monolythic .1uF, 50V	SR205E104MAA	AVX
C9	Capcitor, Electrolytic 20uF, 150V	TVA-1410	Sprague
D1,2	Diode 6A, 100V	60S1	IR
D3-6	Diode 1A, 100V	1N4004	Motorola
F1	Fuse 4A, 32V	303004	Littelfuse
F2,3	Fuse 1.5A, 32V	30301.5	Littelfuse
Q1	Transistor, NPN	2N3583	RCA
*R1,2	Resistor, Wirewound 1 ohm, 3W	RW69V1R0	Dale
*R3,4	Resistor, Wirewound 5 ohm, 5W	RW67V5R0	Dale
R5	Resistor, Metal film 20K, 1/4W, 1%	RN55D 2002F	
R6	Resistor, Metal film 110K, 1/4W, 1%	RN55D 1103F	
R7	Resistor, Metal film 13.7K, 1/4, 1%	RN55D 1372F	

PARTS LIST

Description DC POWER SUPPLY, REGULATED

Assembly/part no. 16-173

Drawing/ref no. B-2024, B-2025

Model KBT-

REF.	DESCRIPTION	MANUFACTURER'S NUMBER	MANUFACTURER
*R8	Resistor, Metal film 51.1K, 1/4W, 1%	RN55D 5112F	
R9	Resistor, Metal film 887K, 1/4W, 1%	RN55D 8773F	
R10	Resistor, Metal film 22.1K, 1/4W, 1%	RN55D 2212F	
R11	Resistor, Metal film 2.21K, 1/4W, 1%	RN55D 2211F	
R12	Resistor, Metal film 1K, 1/4W, 1%	RN55D 1001F	
U1	Quad operational amplifer	RC4136DB	Raytheon
VR1	Voltage regulator +15V, 1.5A	MC7815CT	Motorola
VR2	Voltage regulator -15V, 1.5A	MC7915CT	Motorola
Z1	Zener diode 62V, 5W	1N5372 B	IR
1pc	IC Socket 14 contact	14S-TSD	CA
6pcs	Fuse clips PCB 1/4", Dia.	102080	Littelfuse
1pc	Printed circuit board	15-083/A	Behlman Eng.

* Value may vary with application.

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25070	YELLOW
25071	BLACK
25072	LIGHT BLUE
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25074	LIGHT GRAY
25075	LIGHT GREEN
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25078	RED
25079	EXECUTIVE RED

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